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USER'S GUIDE

MODEL: IG200-5

PART NO. : DS25-457

Hipotronics inc.

applied high voltage technology for industry utilities & science

MP MASTER
MA35118

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USER'S GUIDE

MODEL: IG200-5

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DANGER HIGH VOLTAGE

WARNING: This publication describes a product engineered and designed to supply HIGH VOLTAGE Accordingly, maximum safeguards have been built into the equipment and the best safety techniques possible are set forth in the unit's operating instructions. These instructions contain cautions, warning the user to exercise great care in the use of certain controls and at appropriate points in the operating procedures. Despite these written warnings the operator of this equipment is nevertheless strongly advised to maintain a safety consciousness at all times. The following rules are particularly relevent and must be followed at all times.

BEFORE CONNECTING INPUT POWER, GROUND CASE.
BEFORE UNGROUNDING CASE, DISCONNECT POWER.

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IMPULSE GENERATOR SYSTEM MANUAL
TABLE OF CONTENTS

SECTION	PAGE
SAFETY NOTICE	1
SPECIFICATIONS	2
GENERAL INFORMATION AND REQUIREMENTS	3
Introduction	3
Equipment Description	3
Functional Characteristics	4
Meter Accuracies	4
Charging Voltmeter	4
Gap Breakdown Meter	4
Capabilities & Limitations	5
Equipment Supplied	6
PRINCIPLES OF IMPULSE TESTING	
Basic Terms	7
Basic Theory	8,9,10
Duration of Impulse Wave Rise & Delay Times Figure 1-3B (AI25-234)	11
I.E.C. Wave Shape Specifications (AI25-235)	12
Oscillatory Impulse Wave Effect of Inductance On Impulse Wave (AI25-236)	13
Effect of Inductive Load on Impulse Generator, Relationship of Capacitance & Inductance (AI25-237)	14
TECHNICAL DESCRIPTION	
Impulse System Parameters Figure 7	15
Circuit Notes	16
Wave-Tail Calculations	17
Wave Front Calculations	18
Efficiency	18
Notes on Testing Lightning Arrestors	19 & 20
Wave Shaping Resistors	21
HV Power Supply	22
HV Capacitors	22
Capacitive Divider (option) Fig. 10	23
Resistive Divider Figure 11	24 & 26
ISO-80A Impulse Surge Oscilloscope	27
Polarity Option	28

TABLE OF CONTENTS--CONT.

SECTION	PAGE
OPERATION PROCEDURE	29
Control Functions	29
Generator Energization	29
Polarity Reversal	29
Operational Shut-Down	29
Operational Modes	30
Output Calculation	30
Peak Reading Voltmeter	30
Meter Calibration	30
PERIODIC MAINTENANCE	31
TROUBLE SHOOTING	32
INSTALLATION	33
TRIGGER SYSTEM Figure 12	34
ASSEMBLY NOTES & PHOTOGRAPHS	35-46
Spark Gap Adjustment	35
TRACING OF INTERFERENCE SOURCES	47
Measuring Equipment	47
Test Object	47
RECOMMENDED GROUNDING SYSTEM	48-49
EQUIPMENT INSTALLATION	50
ILLUSTRATIONS	
Schematic - Design & Connection of Isolation Transformer Figure 13	51
Recommended Control Cable Wiring Figure 14	52
Schematic - Impulse Equipment Figure 15	53
Recommended Layouts of Impulse Circuit BI25-339 Figure 16 A,B,C	54
GAP VOLTAGE CIRCUIT (AF30-197-1)	
PULSE TRIGGERING CIRCUIT (AF30-227-1)	
OUTLINE FOR STANDARD IG WITH .5 UF 100 KV CAPACITORS DA25-189	
SERIES PARALLEL DIAGRAMS/TABLES	
PARTS LIST	
SCHEMATIC	

SAFETY NOTICE

DANGER HIGH VOLTAGE

GROUND CASE BEFORE CONNECTING INPUT POWER

DISCONNECT INPUT BEFORE UNGROUNDING CASE.

This equipment employs voltages which are dangerous and may be fatal if contacted by operating personnel. Extreme caution shall be exercised when working with equipment. While every practicable safety precaution has been incorporated in this equipment, the following rules must be strictly observed:

KEEP AWAY FROM LIVE CIRCUITS

Operating and maintenance personnel must at all times observe all safety regulations. Do not change components or make adjustments inside equipment with voltage supply on. Under certain conditions, dangerous potentials may exist in circuits with power controls in the off position due to charges retained by capacitors. To avoid accidents, always remove power, then discharge and ground by use of grounding rod, prior to touching any parts.

DON'T TAMPER WITH INTERLOCKS

Do not depend upon door switches or interlocks for protection, but always shut down high voltage rectifiers and other power equipment. Under no circumstances should any access gate, door or safety interlock switch be removed, short circuited, or tampered with in any way, except by authorized maintenance personnel when considered unavoidable, nor should reliance be placed upon the interlockswitches for removing voltages from the equipment. The ground rod should always be employed (after shuttingoff all power) to ensure that circuits are electrically "dead".

SPECIFICATIONS

MODEL NUMBER	IG200-5	
SERIAL NUMBER	005349-00	
MFG. DATE	12/82	
RATING (Charge Voltage)	200	KV
ENERGY PER STAGE	2.5	Kj
INPUT POWER	220V	VOLTS
	10	AMPS
	50/60	HZ.
RESISTIVE DIVIDER		
UPPER ARM	3.2	k Ω
LOWER ARM	76.5	Ω
Ratio (including 75 Ω Scope Termination)	84.5:1	
CAPACITIVE DIVIDER	N/A	
MEASURED RATIO	N/A	
MIXED FAST DIVIDER		
MEASURED RATIO	N/A	

GENERAL INFORMATION AND REQUIREMENTS

INTRODUCTION

The purpose of this manual is to familiarize personnel with the set-up and operation of Hipotronics Impulse Generators.

EQUIPMENT DESCRIPTION

Hipotronics Impulse Generators are designed for simulating lightning or transient voltage phenomena resulting from equipment association with power distribution systems. The need for components which will reliably withstand (short duration) over voltage wave-forms demands that simple, safe lightning simulators be available. The resulting product is a test system which includes a control console, high voltage power supply, capacitor bank with switching arrangement and waveform monitoring oscilloscope.

In operation the generator, less controls, is installed in a safe test area. After the test sample has been connected to the high voltage output and ground return, the capacitor bank is charged to the desired test voltage. When the preselected voltage is reached, charging is halted by electro-mechanical means. At this time an isolated electronic trigger delivers a pulse to discharge the capacitor bank. Simultaneously, a photograph is taken of the waveform displayed on the oscilloscope.

For various international standards, different wave-forms of the applied impulse may be simulated by changing plug-in resistors located on the capacitor bank.

CAPABILITIES AND LIMITATIONS -

Maximum charge time to rated voltage 30 seconds.

Duty cycle for Maximum Voltage

SHOTS/MINUTES	MINUTES ON	MINUTES OFF
4	10	10
3	13	10
2	15	5
1	Continuous	

Minimum successful firing voltage 5 kV/stage.

EQUIPMENT SUPPLIED

ARTICLE	SIZE	WEIGHT	FUNCTION
Control Cabinet	21"W x 19"D x 11"H	50 lbs.	Control Console
Tank	24"x24"x 48"	500 lbs.	Regulator and HV Power Supply
Measuring Column	13"/Stage	20 lbs./ Stage	Resistive Divider
Generator Assy.			
Base	5'x6'x8"	200 lbs.	HV Marx Assembly
HV Capacitors	29"x6"x21"	125 lbs.	Stage Capacitor
Fiberglass Standoffs	4"x12-1/2"	1 lb. ea.	Upper Stage Supports
Fiberglass Standoffs	4" x 21-3/4"	1 lb. ea.	First Stage Supports
Permali Support	2" x 10"	2 lbs. ea.	HV Input Terminal
Fiberglass Shaft	3"ODx13"+11"/Stage	5lbs/Stage	Moveable Drive
Fiberglass Shaft	4"ODx15"+11"/Stage	7lbs/Stage	Fixed Gap Tube
Motor Drive	16"x12"x2-1/2"	25 lbs.	Gap Motor Drive
Steel Plate	42" x 32"	30 lbs.	Top Deck

PRINCIPLES OF IMPULSE TESTING

1. Basic Terms

The basic terms involved in impulse testing are explained below.

a. Impulse (or Surge) - A unidirectional pulse voltage rising to a crest and then decaying to zero - The rise time is normally shorter in duration than the decay. Both the rise and the decay will be of exponential or near exponential form.

b. Wave Front - The part of an impulse which occurs before the crest - The term may also mean the duration of the wave front.

c. Wave Tail - The part of the impulse occurring after the crest - The term may also mean the duration of the wave tail.

d. Full Wave - A normal impulse wave.

e. Chopped Wave - An impulse wave which is suddenly interrupted- The interruption causes the voltage to rapidly collapse to zero.

f. Switching Surge - An impulse of long duration with the wave front usually between 50 and 1,000

g. Aspect Ratio - The ratio between the wave tail and wave front durations.

I.E.C. Specifications for wave shapes.

Although most impulse testing is at present carried out to National Specifications, the latter have either been re-drafted or are in the course of being re-drafted to line up with the I.E.C. Specification. To avoid confusion therefore, only the I.E.C. Specifications for wave shape and for the measurement of wave front and wave tail durations are included in Fig. 4. The wave front duration is equal to 1.67 times the time interval between the points on wave front at which the amplitude is .3 and .9 of the crest value. The wave tail duration is the time between the origin of the impulse wave and the point on the wave tail at which the amplitude is one half of the crest value. The standard impulse wave has a wave front duration of 1.2 microseconds and a wave tail duration of 50 microseconds. It is described as a 1.2/50 microsecond wave.

II. Basic Theory

Behaviour of Simple Resistance-Capacitance Circuits. In order to appreciate the method of operation of an impulse generator, it is necessary first to understand the behaviour of certain simple R.C. circuits. These circuits are shown in Fig. 1, 2, 3A and 3B. In the circuit of Fig. 1 a capacitor Cg is charged to a voltage Vc. It is then discharged by means of a switch into a resistor Rt. The ensuing voltage wave form appearing across the resistor Rt is shown in the accompanying graph. The voltage rises instantaneously to Vc and then decays in an exponential manner to zero. The time taken for the voltage to decay to .5 Vc is equal to .7 times Cg. Rt. This simple circuit may be used for generating an impulse wave with a wave front of zero duration and a wave tail of exponential form. In Fig. 2 a capacitor Cg is charged to a voltage Vc and then discharged by means of a switch through a resistor Rf into a capacitor Cl. The variation in the voltage appearing across G1 with time is shown in the accompanying graph. The voltage rises exponentially and would ultimately reach a value of Vc times Cg divided by (Cg plus Cl). Such a circuit may clearly be used to produce a wave front and an infinite wave tail. The wave front duration will depend on the product of Rf and the total series capacitance of Cg and Cl. If Cg is much larger than Cl the wave front duration will be dependent upon the product of Rf and Cl.

In Fig. 3a the circuits of Fig. 1 and Fig. 2 have been combined. The accompanying graph shows the variation in the voltage across the capacitor Cl with time after the closure of switch. The voltage rises exponentially to a peak and then decays exponentially to zero. The crest value of the voltage is equal to KVc, Cg divided by Cg plus Cl. K is a factor which depends upon the wave shape. The circuit of Fig. 3a is known as a high efficiency circuit. The circuit in Fig. 3b is known as a low efficiency circuit. The difference between the two circuits is in the relative position of Rf and Rt. In the case of the circuit of Fig. 3B, the resistors Rf and Rt act as a potentiometer. Consequently the voltage appearing across Cl is reduced by a factor Rt divided by Rt plus Rf.

The effect of series inductance on the simple R.C. circuit. If an inductance L is included in series with the resistance Rf in the circuit of Fig. 3A, the wave form of the output voltage is modified. See Figure 5. If Rf is less than 2 times the square root of L divided by C1 then the wave will become oscillatory. Since the presence of this oscillation is not permissable, it is important that Rf should be of sufficient value to ensure damping. Thus the minimum wave front duration that can be obtained under these circumstances is dependent upon the values of L and C1. An impulse generator should have as little inductance as possible in order to ensure that short wave front durations are obtainable.

The effect of inductive (transformer) loading upon the impulse wave form. In most cases the impedance offered to an impulse generator by a test object is purely capacitive. However, in the particular case of a transformer, the impedance is a parallel arrangement of capacitance and inductance. It is therefore important to study the effects of this combination upon the output of the circuit of Fig. 3a. Fig. 6 the output of the impulse generator circuit applied to a capacitor C_L which is connected in parallel with an inductance L_L. In the case where L_L is made infinitely large, a normal double exponential wave is obtained. However, as the inductance L_L is reduced two things can happen. If the wave front resistance Rf is high, then the wave tail duration will decrease and will, if L_L is made small enough, undergo a single reversal of polarity. If Rf is small in ohmic value, then as L_L is reduced the wave tail decreases, ultimately becoming oscillatory. The wave tail duration is longer when Rf is made small. For a given value O/L_L in the limit, for small values of Rf the wave tail duration will depend upon L1 divided by Rf. Therefore it is important when testing inductive loads to ensure that the value of Rf is as small as possible.

Switching surge waveforms. Some particular problems arise in the generation of switching surge waveforms. The first of those is that the ohmic values of the resistors used are very much higher than those required for the generation of 1.2/50 microsecond waves. If the charging resistors are not to have any effect upon the impulse conditions of the circuit then their ohmic values must also be made very much higher.

Switching surge testing of transformers. The techniques used in the switching surge testing of transformers may be somewhat different to those normally employed during transformer testing with 1.2/50 microsecond waves. The first major difference is in the connection of the transformer itself. It is not possible to conduct switching surge tests on a transformer winding when the other windings of the transformer are short circuited. To obtain a wave of long duration under these circuimstances would require an impossible generator capacitance. Consequently, such tests are conducted with all other windings open circuited and in this case, the inductance across which the voltage wave is impressed is the magnetising inductance of the transformer. Under certain circumstances. the duration of the impulse wave may be sufficiently long to cause saturation of the transformer core, resulting in a rapid collapse of the impulse wave. The transformer can be tested by applying an impulse to the low voltage winding in order to induce a test voltage onto the high voltage winding. In testing transformers with switching surge waves, it is advisable to use as low an ohmic value as possible for the wave front resistor. This may require the addition of a substantial preload capacitance to the circuit.

The generation of chopped wave impulses. In general, two types of chopped waves have to be produced. The most common is the tail chop in which the impulse is suddenly reduced to zero at a point shortly after its crest. This type of impulse wave is used only in the testing of power transformers. Chopping may sometimetimes be required on the wave front. Front chopped waves are specified only in test to American standards on power transformers. The production of a chopped impulse wave is achieved by suddenly, short circuiting the impulse generator by means of a spark gap. If accurate timing of the chop is not important then a rod or sphere gap may be employed. When accurate timing is important as in transformer testing, some form of triggatron type device is desirable. Hipotronics multiple element chopping gaps provide a simple means to accurately control the chop time.

REVISIONS			
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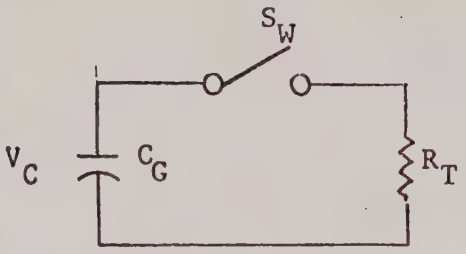


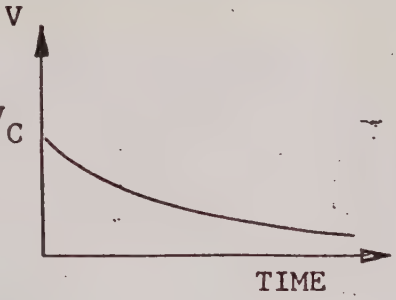
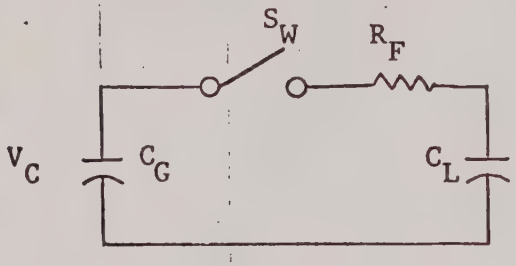


FIG. 1



$$\frac{V_C\ C_G}{C_G+C_L}$$

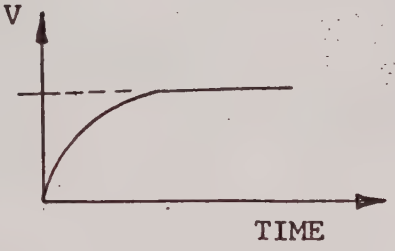
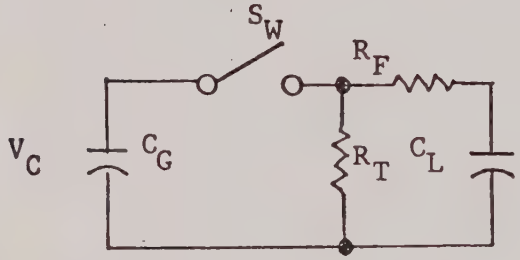


FIG. 2



$$\frac{k\ V_C\ C_G}{C_G+C_L}$$

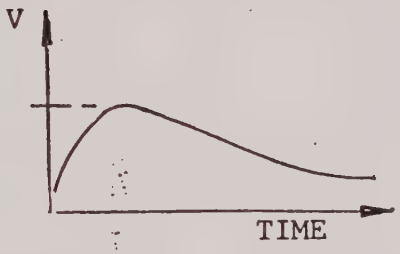
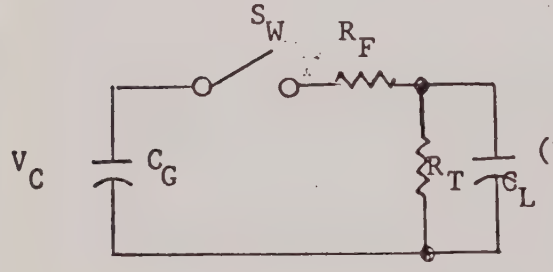


FIG. 3a



$$\frac{k\ V_C\ R_T\ C_G}{(R_T+R_F)(C_G+C_L)}$$

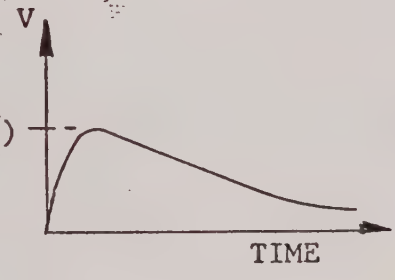


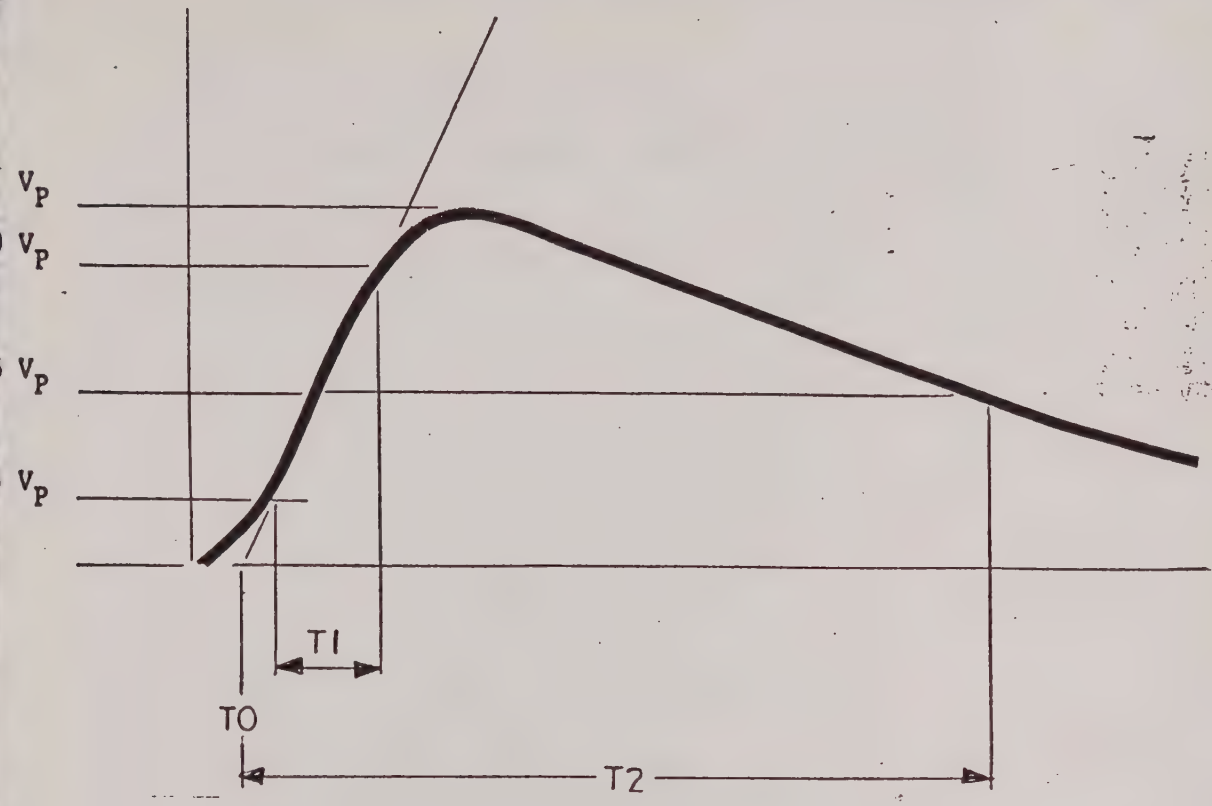
FIG. 3b

DURATION OF
IMPULSE WAVE
RISE & DELAY TIMES

HIPOTRONICS
BREWSTER, N.Y.

NEXT ASSY		MODEL NO IMPULSE GENERATOR			
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES DO NOT SCALE DWG TOLERANCES		DRAWN	DATE 6-20-77	DWG NO. AI 25-234	REV.
		CHECKED			
FRACTIONS ±1/64	DECIMALS ± .005	ANGLES ±30'	APPROVED FSH	6-77	SCALE / SHT 1 OF 1

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED



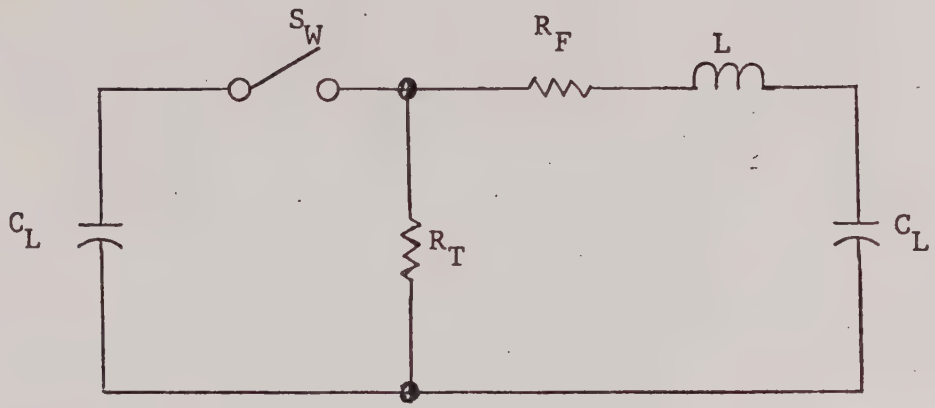
FOR I.E.C. FRONT DURATION = 1-67 x T1 TAIL DURATION = T2

FOR STANDARD IMPULSE WAVE I.E.C. SPECIFIES A WAVEFRONT DURATION OF 1·2 MICROSECONDS ± 30% AND A WAVETAIL DURATION OF 50 MICROSECONDS ± 20%

FIG. 4

I.E.C. WAVE SHAPE SPECIFICATIONS		HIPOTRONICS BREWSTER, N.Y.			
NEXT ASSY		MODEL NO IMPULSE GENERATOR			
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES DO NOT SCALE DWG TOLERANCES		DRAWN R	DATE 6·20·77	DWG NO. AI 25-235	REV.
		CHECKED			
FRACTIONS ± 1/64	DECIMALS ± .005	ANGLES ±30'	APPROVED FSu	6-77	SCALE / SHT 1 OF 1

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED



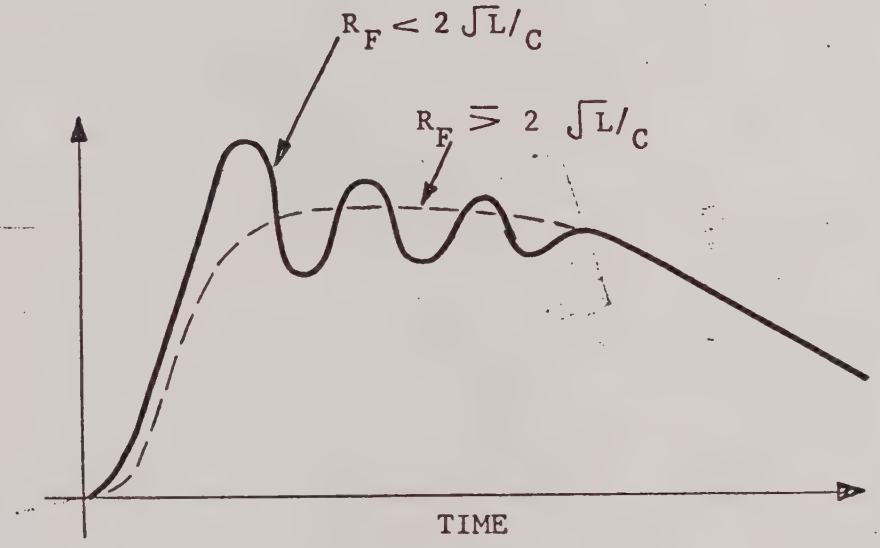


FIG. 5

OSCILLATORY IMPULSE WAVE
EFFECT OF INDUCTANCE ON
IMPULSE WAVE.

HIPOTRONICS
BREWSTER, N.Y.

NEXT ASSY		MODEL NO IMPULSE GENERATOR	
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES DO NOT SCALE DWG TOLERANCES		DRAWN	DATE 6-20-77
		CHECKED	
FRACTIONS ±1/64	DECIMALS ±.005	ANGLES ±30'	APPROVED 6-77

DWG NO. AI25-236 REV.

SCALE SHT 1 OF 1

REVISIONS			
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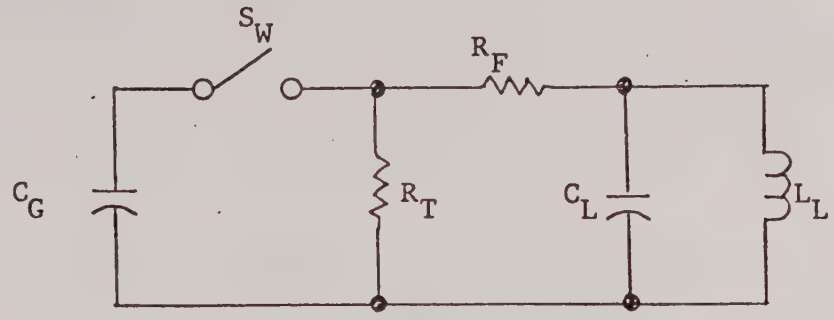


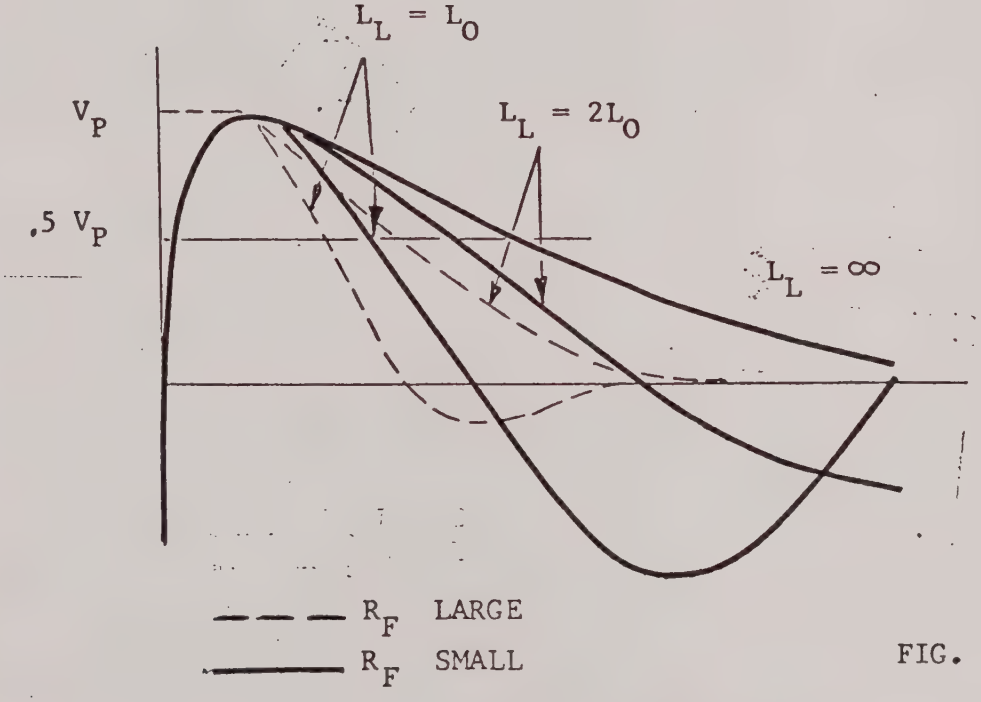


FIG. 6

EFFECT OF INDUCTIVE LOAD ON IMPULSE GENERATOR.
RELATIONSHIP OF CAPACITANCE & INDUCTANCE.

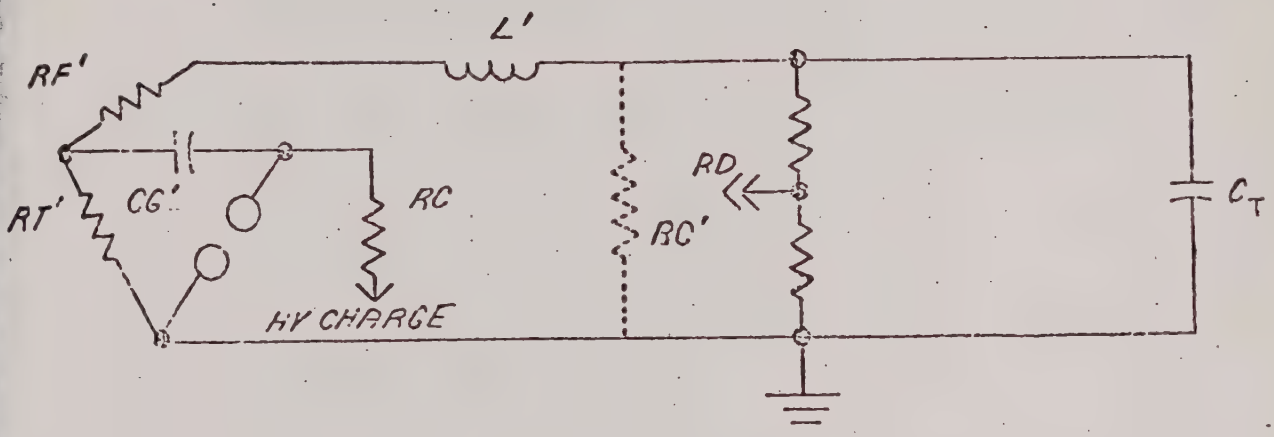
HIPOTRONICS
BREWSTER, N.Y.

NEXT ASSY		MODEL NO IMPULSE GENERATOR			
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES DO NOT SCALE DWG TOLERANCES		DRAWN	DATE 6-20-77	DWG NO. AI 25·237	REV.
		CHECKED			
FRACTIONS ±1/64	DECIMALS ±.005	ANGLES ±30'	APPROVED	6-77	SCALE / SHT 1 OF 1

IMPULSE SYSTEM PARAMETERS

Given an Impulse System as follows:

FIGURE 7



Where

$Cg' = Cg/_N$

$C_T = C_L + C_{PL} + C_S + C_D$ (load, preload, stray, divider capacitances)

$R_T' = NR_T$

$R_F' = NR_F$

$Rc' = \frac{N^2}{N-1} (Rc + R_F)$

$L' = NL_S + L_1$

N = number of impulse generator stages

NOTE

The resistance Rc' is that resistance which, if connected as shown above would have the effect on the single stage model as does the $Rc + R_F$ resistance combination on a multi stage impulse generator.

This resistance (Rc') need only be considered when a multi stage impulse generator is being used to produce long duration waveshapes.

And

C_g = GENERATOR STAGE CAPACITANCE

C_L = CAPACITANCE OF TEST OBJECT

C_D = CAPACITANCE OF VOLTAGE DIVIDER

C_S = TOTAL STRAY EARTH CAPACITANCE

R_T = WAVE TAIL RESISTANCE PER STAGE

R_F = WAVE FRONT RESISTANCE PER STAGE

Rc = CHARGING RESISTANCE PER STAGE

Ls = GENERATOR STAGE INDUCTANCE

L_1 = INDUCTANCE OF GENERATOR TEST LOOP

C_{PL} = PRELOAD CAPACITANCE

CIRCUIT NOTES

The generator circuit employed is a high efficiency Marx arrangement. Generally for generators below 1 MV the stray capacitance (C_S) can be considered to be less than 100 pF. The inductance per stage is roughly 2 microhenrys including the inductance of the parallel combination of front resistances.

The inductance of the test loop may be considered to be roughly 1 microhenry per meter.

WAVE-TAIL CALCULATION

Assuming R_F' is small compared to R_T' the tail duration is:

$$T_t \simeq 0.7\ (Cg' + C_T) \times \frac{R_T'\ Rc'}{R_T' + Rc'} \quad \text{MICROSECONDS}$$

For lightning impulses it is normal to make Rc at least 20 times larger than R_T.

Therefore, the above formula can be simplified.

$$T_t \simeq 0.7\ (Cg' + C_T) \times R_T' \quad \text{MICROSECONDS}$$

or referring the Resistance Capacitance values to the single stage.

$$T_t \simeq 0.7\ (Cg + NC_T) \times R_T.$$

Note

A further approximation can be made for the case where C_T is small compared to Cg'.

Therefore

$$T_t \simeq 0.7\ Cg \times R_T.$$

WAVE FRONT CALCULATION

Wave front resistance per stage can be calculated from:

$$T_R \simeq 2.5 \times R_F' \times C_T$$

Extremes of loading or excessive inductance may give values differing from calculated ones. For most cases, however, these methods will be well within the ± 30% Tolerance for the front time of 1.2 microseconds according to IEC 60.

EFFICIENCY

For most normal loading conditions the efficiency may be calculated as

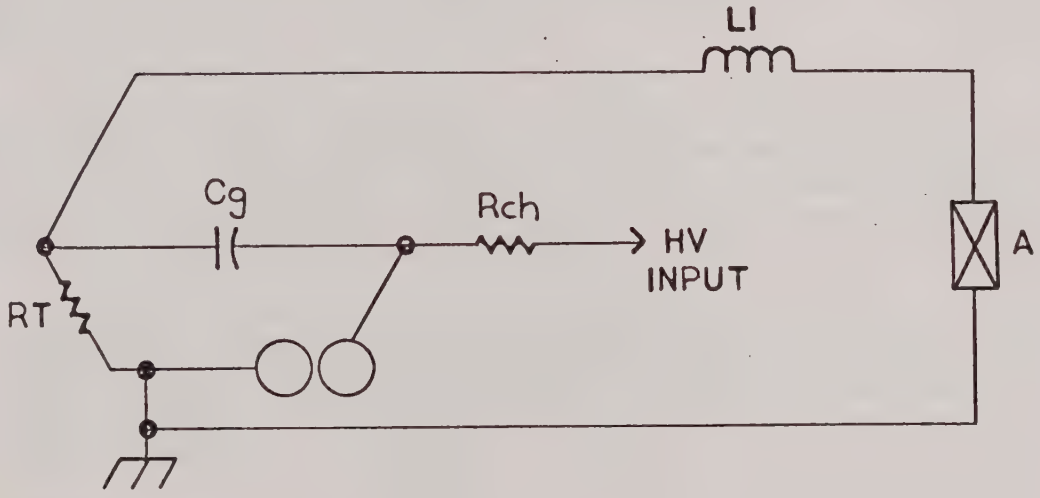
$$\eta = \frac{V_P}{NV_C} = \frac{(Cg')}{(Cg' + C_T)} \times \left(\frac{Rc'}{R_F' + R_C'}\right) \times K$$

Where Vp = Crest Output Voltage (Kilovolts)
V_C = Stage charging voltage (Kilovolts)
K = Aspect Ratio Constant
For a standard 1.2x 50 microsecond wave shape K=0.95

NOTES ON TESTING LIGHTNING ARRESTORS

Hipotronics Impulse Generators may be reconnected as current generators to be used for high current lightning arrestor testing. In all cases, it should be remembered that generating high current waves inevitably leads to severe voltage reversal on the generator capacitors during impulse conditions. The voltage reversal should be observed as usual with the voltage divider and scope. Reversal should be limited to 80% unless the generator has been specifically designed for current surge testing.

In order to produce one of the standard current waveforms the normal Marx circuit must be modified. The modification consists of short circuiting all front resistors, paralleling the impulse generator capacitors to obtain the desired waveform, increasing the tail resistors to a high (>1000 Ω) value and adding inductance in series with the lightning arrestor. The circuit becomes: See Figure 1



Where

Cg = Generator Net Capacitance or Capacitance/Stage times "N" Stages in parallel

R_T = Tail Resistance (R_T > 1000 Ω)

R_{ch} = Normal charging resistance

L_1 = Series Inductance

A = Arrestor under test

For standard waves of 4 x 10 or 8 x 20 according to IEC

$$T_{RISE} \approx 1.25 \sqrt{L_1 \times Cg} \quad \text{(RISE TIME) IEC}$$

$$T_{FALL} \approx 2.5 \sqrt{L_1 \times Cg} \quad \text{(TIME TO HALF VALUE) IEC}$$

The Peak Current available may be approximated from

$$\hat{I} = \frac{Ec - E_R}{\sqrt{L/C}}$$

where

E_C = charging voltage of the generator
E_R = Residual voltage of the Arrestor
L = Total Generator inductance including 1 uH/meter for leads
C = Net Generator Capacitance
$\hat{I}$ = PEAK OUTPUT Current

TEST ARRANGEMENT

Since high currents are being generated, it is imperative to minimize system connection losses. Connections should be made with wide copper foil (25 cm x 1 mm). All connections should be as short as possible.

When capacitor stages are to be connected in parallel, connections should be as tight as possible.

INDUCTORS

Inductors for waveshaping are selected based on the lightning arrestor characteristics and the test loop parameters. Inductors may be supplied from the factory or made up on site. An easy way to fabricate inductors is to use insulated wire and wind turns on a round insulating form.

Coaxial cable type RG8/U is convenient to use since the shield can be used as a low resistance conductor and the insulation sheath will withstand 5 to 10KV on a pulse basis. Design of simple single layer inductors may be done according to the formula:

$$L = \frac{(RN)^2}{9R + 10\ell}$$

Where

L = inductance in microhenrys
N = total number of turns
R = Mean Radius of the coil (inches)
ℓ = length of the winding (inches)

Taps can be provided to allow adjustability.

CURRENT MONITOR

To view the current waveform any suitable low inductance shunt or Pierson type wide band current transformer may be used. The Pierson current transformer has the advantage of being electrically isolated from the high current loop.

WAVE SHAPING RESISTORS

Wave shaping resistor supplied on 100 KV per stage generators are rated for 1.25 Kilojoule each. Provision is made for parallel combinations on all generators to reduce inductance, increase flexibility, and divide the energy. Although all of these vitreous coated resistors are relatively low in inductance, resistors called "non-inductive" are used for front resistances. Normal units are used as Tail Resistance.

It may be noticed that unless very high load capacitance is present (ie $C_T > 0.2\ Cg'$) very little adjustment of tail resistance is necessary. The addition of a preload capacitor will hold generator resistor parameters nearly constant when testing similar capacitance test samples.

HIGH VOLTAGE POWER SUPPLY

Each impulse system comes complete with a conservatively designed power supply. Great care has been taken to protect the power supply from high current transients encountered in impulse testing. The circuitry is a conventional full wave bridge. Rectifiers are rated 50 mA, 230 kV PIV. All rectifiers are the high voltage selenium type.

Each supply contains an internal current limiting resistor and an electrically operated solenoid to discharge the generator. Every transformer manufactured at Hipotronics undergoes a thorough quality control check to assure corona free operation.

The coaxial high voltage output cable eliminates dangerous buss work and exposed bushings.

HIGH VOLTAGE CAPACITORS

All impulse capacitors used in Hipotronics Impulse Generators are designed and manufactured in our Brewster, New York plant. These capacitors are designed for a minimum of 1.0 million full voltage shots with no reversal and 500,000 shots with 80% reversal. Internal construction consist of Kraft paper, polyester film, castor oil dielectric, with swedged low inductance sections. Cycloaliphatic epoxy bushings manufactured by Hipotronics are selected for use in a shop environment where dirt built-up is inevitable. Each capacitor contains high resistance bleeder resistors to discharge the capacitors in the event that any wave shaping resistor open circuits. Always discharge all bushings and the capacitor cans before touching any generator components.

CAPACITIVE DIVIDER

An optional low inductance divider may be ordered as an option for monitoring wave-forms longer than the standard BIL waves. Each divider is provided with a low arm to give a ratio with excellent temperature tracking ability. Alternate LV arms can be provided to change the ratio.

Capacitive Dividers are mixed R-C type with built in damping resistance. An external lead dampin, resista is selected to optimize the divider response.

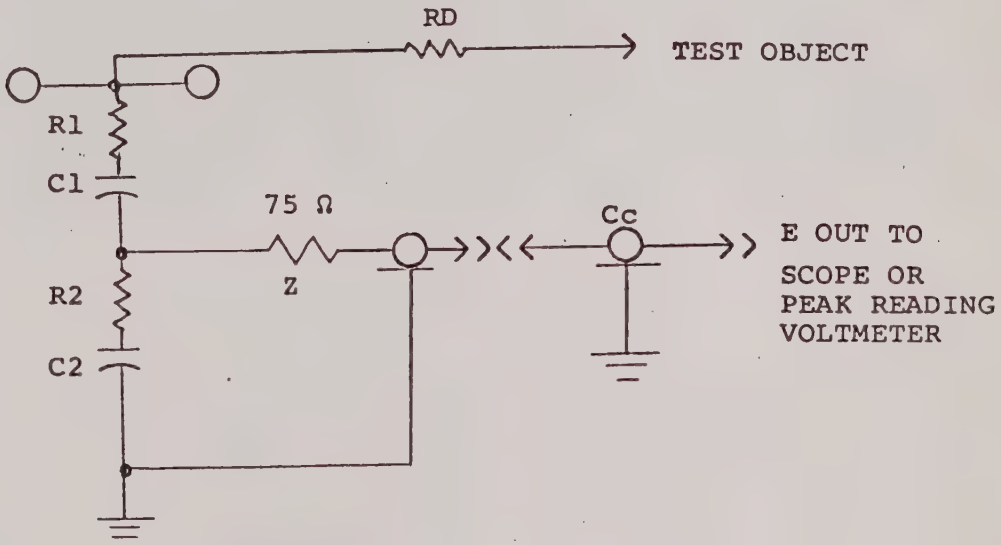


FIGURE 10

R_1 HV Damping Resistance

R_2 LV Damping Resistance

C_1 = HV Arm

C_2 = LV Arm

Z = Cable Terminating Impedance
RD = HV Lead Matching Resistance
C_C = Capacitance of Measuring Cable

The time consultants for the LV arm are matched according to:

$$(R_D + R_1)\ (C_1) = R_2C_2$$

A cable impedance matching resistance is included either at the divider end or at the oscilloscope end in the case of the ISO-80.

The divider ratio is measured by applying HV AC with the meausuring cable connected.

Step response is measured according to IEC 60.

Divider data is provided in the back pocket of this manual.

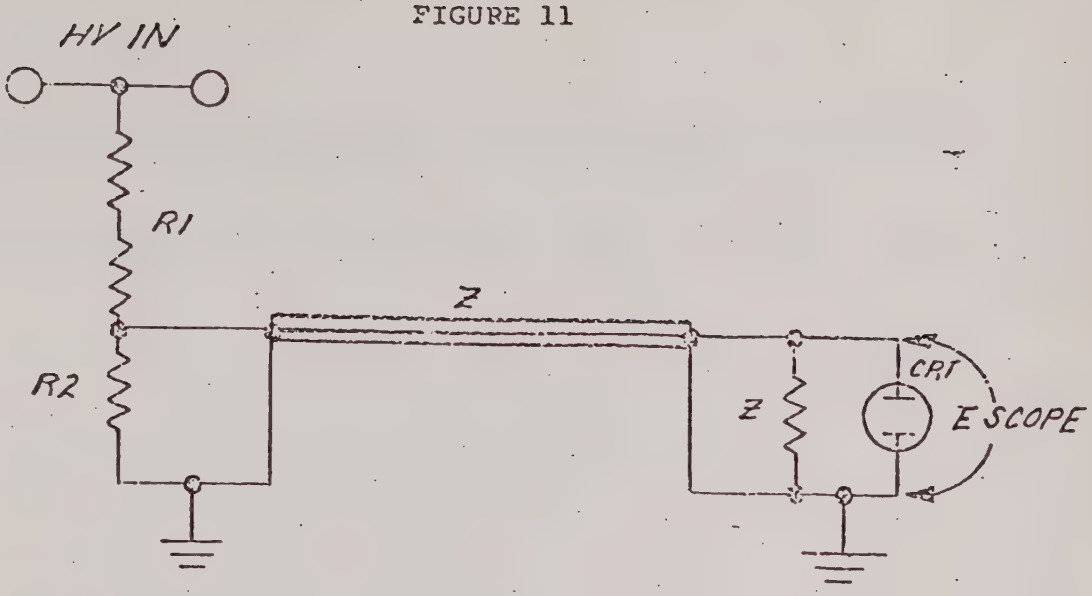
RESISTIVE DIVIDER

Each impulse system rated 1200 kV or lower is supplied with a non-inductive resistive divider for monitoring short duration wave-forms. Resistor dividers should only be used for wave-forms less than 500 micro-seconds in duration. The measured resistance of the divider is shown on the main schematic.

The measured response time of the divider is approximately 100 nano seconds.

To check the ratio after installation, place a "T" connector in series with the 75 Ω input to the ISO-80 oscilloscope. Since variations in input impedance of the oscilloscope are possible, a measurement of the lower arm resistance as terminated is necessary. A good digital ohmmeter is helpful. After measuring the low arm with the cable as connected to the oscilloscope, measure the upper resistance of the divider R1. The resulting divider ratio may be found by using the formula on the following page.

FIGURE 11



$$E\ Scope = \frac{\dfrac{R1}{\dfrac{(R_1 \times R_2)}{(R_1 + R_2)}} \times Z}{\dfrac{(R_1 \times R_2)}{(R_1 + R_2} + Z}$$

R_1 = HV Arm

R_2 = LV Arm

Z = Terminating Impedance (ISO-80 = 75 Ω)

Or, where $\frac{R1}{R2}$ is greater than 100 [which is usually the case]

$$E\ Scope = \frac{\dfrac{R_2 \times Z}{R_2 + Z}}{R_1 + \dfrac{R_2 \times Z}{R_2 + Z}} \times H.V.\ IN.$$

ISO-80 SURGE OSCILLOSCOPE

Consult the accompanying instruction maunal for main details on scope operation. All interconnections between the scope and the generator are done with the RG11/U cable supplied.

Each Hipotronics impulse generator is provided with dual oscilloscope trigger facilities for triggering two scopes.

AUTOMATIC POLARITY OPTION

When ordered, a control module switch allows completely automatic polarity reversal, is installed. Polarity changeover is inhibited while the charging process is on.

OPERATION PROCEDURE

INPUT CONNECTION

Input power connections are made at the power supply. The main input power breaker and indicator lamp are located in the regulator module on top of the power supply. Interconnect cables are all terminated in plug-in connectors.

CONTROL MODULE

The following controls are located on the control panel:

1) Control power ON switch with indicator lamp.
2) High voltage ON-OFF pushbuttons with indicator lamp.
3) Interlock warning lamp.
4) Trigger (impulse) pushbutton.
5) Charge rate selector.
6) Dual range kilovoltmeter with high set point.
7) Gap open-close switch.
8) Gap breakdown meter.
9) Meter calibration access hatches.
10) External interlock connection provision.
11) Impulse ready indicator.

OPERATION

1) After connecting all appropriate cables and grounds, main input power may be applied.
2) After determining the efficiency of the circuit an appropriate charge voltage and gap spacing may be selected.
3) The charge rate must be chosen to avoid excessive overshoot. In general the following charge rates may be used.

DESIRED CHARGE VOLTAGE	CHARGE RATE
0-25 kV	Low
26-50 kV	Medium
51-100 kV	High

4) By pressing the HV ON pushbutton the generator will be automatically charged to the value preset on the meter relay.
5) If the ISO-80 impulse scope has been connected to the control module the camera shutter will be triggered when the ready signal is given.
6) The impulse generator may now be fired either from the scope or from the control module.
7) The charging cycle will restart unless HV OFF has been pressed.

OUTPUT CALCULATION

The easiest way to calculate output voltage is from scope traces. To make this calculation, the following procedures should be used.

1) Measure the scope vertical deflection (Er) using a good high impedance voltmeter.

2) Read the percentage of selected attenuator position.

3) Measure the scope trace peak in cm.

4) Note divider ratio

5) Calculation may be made as follows for output voltage (E out).

$$E_{out} = [\text{Deflection cm}]\,[Er]\,[100]\left[\frac{1}{\text{attn percentage}}\right][\text{Divider Ratio}]\ \text{Volt}$$

PEAK READING VOLTMETER

When supplied, the peak voltmeter provides a quick display of output voltage regardless of wave form. Peak meter derives its signal from the voltage divider tap. Consult the data sheet where supplied under optional equipment.

METER RECALIBRATION

Gap meter may be front panel adjusted by charging generator to 50% of rated output. When gaps are opened to the point where the voltage is just held off, the corresponding position on the gap meter may be set.

KV meter may be calibrated by placing a Hipotronics KV100A on the input connection to the generator. Calibration should be at 80% of the low range voltage.

PERIODIC MAINTENANCE

The following procedures should be taken to insure the continued trouble free operation of the impulse system.

ITEM	MAINTENANCE TO BE PERFORMED	MAINTENANCE PERIOD
METER CALIBRATION	Check against standard Hipo Model KV100A or equiv.	Semi-annually
SPHERE GAPS	Dust and check for heavy pitting	Weekly
SHORTING SOLENOID (Oil Tank Models) 100 kV Series Only	Check for actuation	Semi-annually
WAVE RESISTOR	Check value	Semi-annually
RESISTOR DIVIDER	Check value	Semi-annually
TRANSFORMER OIL (in the HV Power Supply)	Sample oil test using Hipotronics OC50A or equiv.	Annually
Interconnect Harness	Check connections & wire condition	Semi-annually
Ground Connection	Check connection & wire condition	Semi-annually
Triggered Spark Gap	Check firing capability	As Necessary

TROUBLE SHOOTING

PROBLEM	ACTION TO BE TAKEN
Generator will not charge	Check supply voltage Check to see if polarity switch is firmly positioned Check for audible action of solenoid in HV tank Check for arcing in HV tank Check charging resistors
Generator will not trigger	Check output of 10 kV supply in pulse unit Check all HV relays for proper operation in pulse unit Check connection of RG11/U delay line Check components and electrode in trigger gap.
Generator will not trigger at low voltage	Align gaps according to manual
Disturbances on Waveform	Check all resistors Review ground recommendation Section Check capacitors Check voltage divider

INSTALLATION

Installation has been greatly simplified by the unitized construction. The following points should be checked over after assembly and before the first time operation procedure is attempted.

1) Position generator in desired location.

2) Check over mechanical connections for possible shipping vibration. Tighten bolts where necessary. Connect power harness to HV section.

3) Consult grounding diagram for correct grounding procedure. No power should be applied to the system without proper grounds. Complete grounding system.

4) Connect HV output cable to standoff on charging side of generator stack.

5) Connect input power.

6) Energize controls with main power breaker.

7) Press pulse button and observe discharge on first gap. Consult trouble shooting guide for help with problems.

8) Drive motor open and closed to check micro switches. Balls should not touch. Adjustment may be made by loosening jam nut behind balls. (See Gap Adjust Section)

9) Press HV ON to listen for solenoid action.

10) Unit is ready for first time operation.

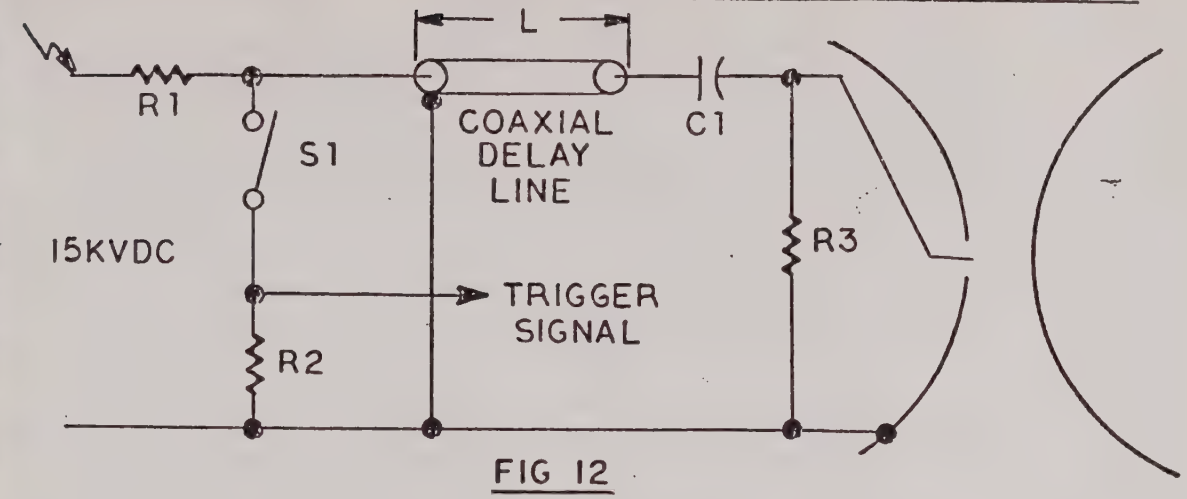


FIG 12

The Impulse Generator trigger system employs a coaxial delay line.

A length of coaxial cable (type RG11 A/U) is charged to approximately 15 kV dc. The far end or (Sphere Gap end) of the cable is connected to the first stage trigger electrode via a blocking capacitor "C1".

When switch "S1" is closed, the cable discharges through "R2". (The value of "R2" is chosen so that the voltage developed across it provides a suitable trigger signal for the IS077A oscilloscope, R2 is typically 0.5 ohm. (RISE TIME 50 NANOSECONDS, 150 V PEAK)

The collapse of the d.c. potential caused by "S1" closure results in a very fast voltage pulse being transmitted down the coaxial cable. This voltage pulse will arrive at the sphere gap end of the cable and double in magnitude (due to transmission line effects) some finite time later. The delay time being dependent on the length of the coaxial cable.

In the case of the Hipotronics triggering system the delay line is 300 feet (91.5 meters) long, corresponding to approximately 0.5 microseconds delay.

The very fast, high voltage pulse, appearing at the trigger electrode of the first stage sphere gap, causes it to flashover, thus firing the impulse generator. The 0.5 micro second delay allows the oscilloscopes to commence their sweep, prior to the start of the impulse waveshape. Two trigger channels are provided to synchronize two oscilloscopes, although polarity of the trigger signal is always correct due to a small pulse transformer, the charging voltage of the pulse supply located on the generator base must be set as follows:

PULSE SUPPLY	GENERATOR MAIN CHARGING SUPPLY
+	+
−	−

ASSEMBLY NOTES

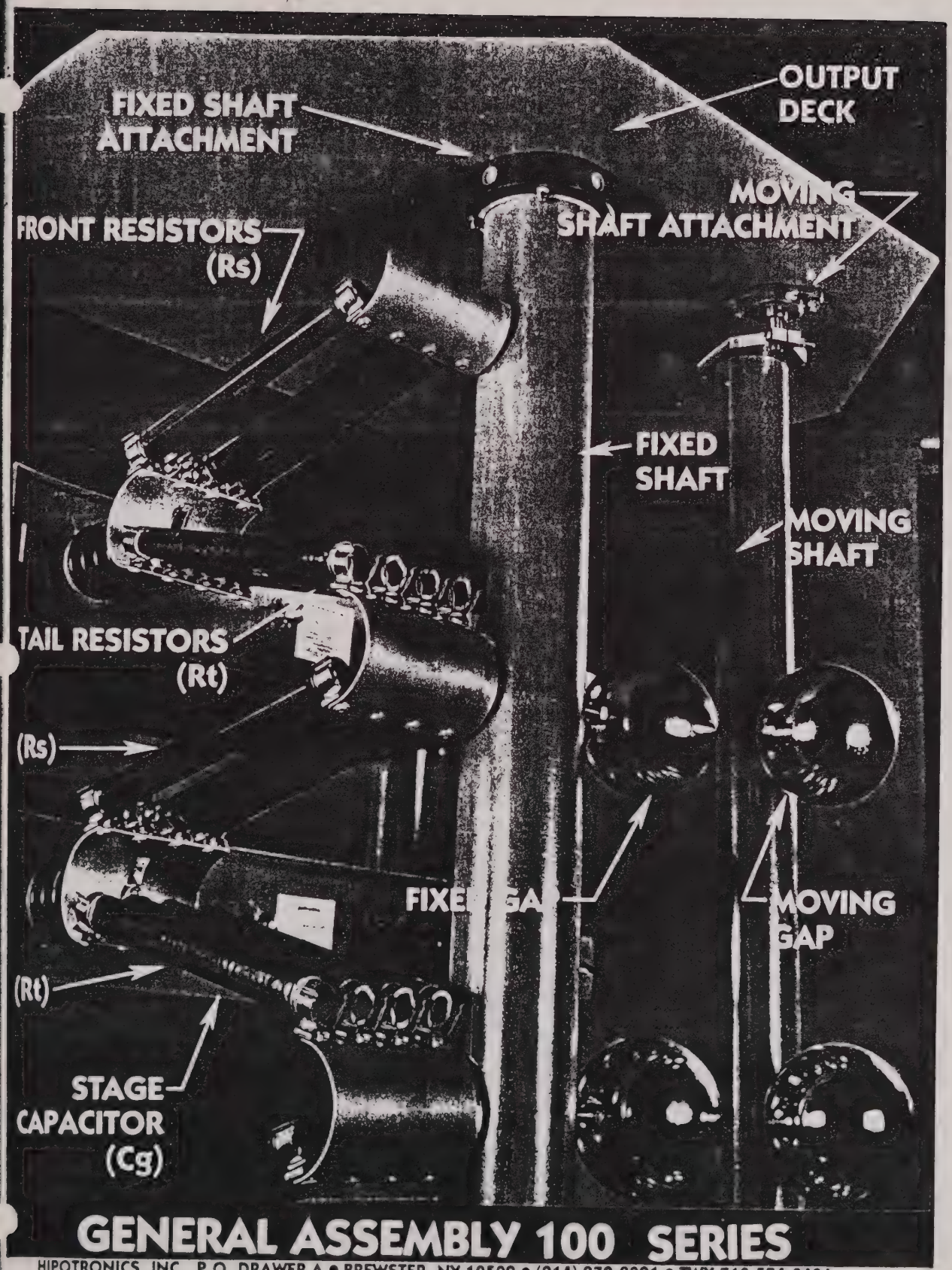
SPARK GAP ADJUSTMENT

1) Spheres (5" Dia.) on fixed and moving anchor shafts should be rotated until approximately 1" of thread is showing. Jam nuts should be tightened to secure the spheres.

2) Adjustment of the gaps may be fine tuned so spacing at the full closed position should be (N x 1/16") where N is the STAGE TO BE ADJUSTED.

3) Microswitches located under the access hatch in the motor drive assembly can be adjusted for minimum and maximum travel. MICRO SWITCHES ARE FACTORY SET AND SHOULD NOT REQUIRE ADJUSTMENT.

4) The 1st stage trigger sphere should be rotated so the spark electrode directly faces the opposing sphere.



GENERAL ASSEMBLY 100 SERIES

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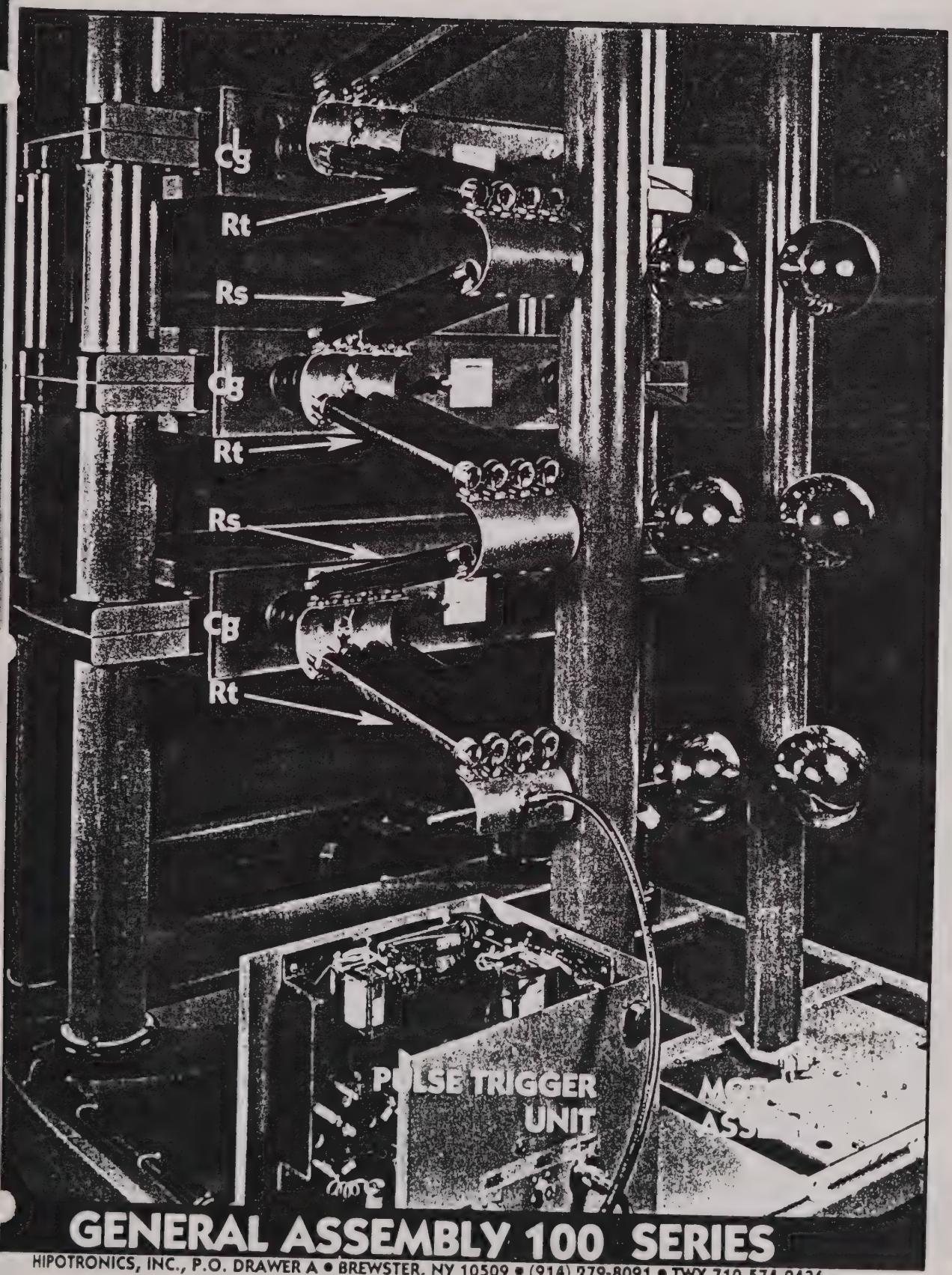

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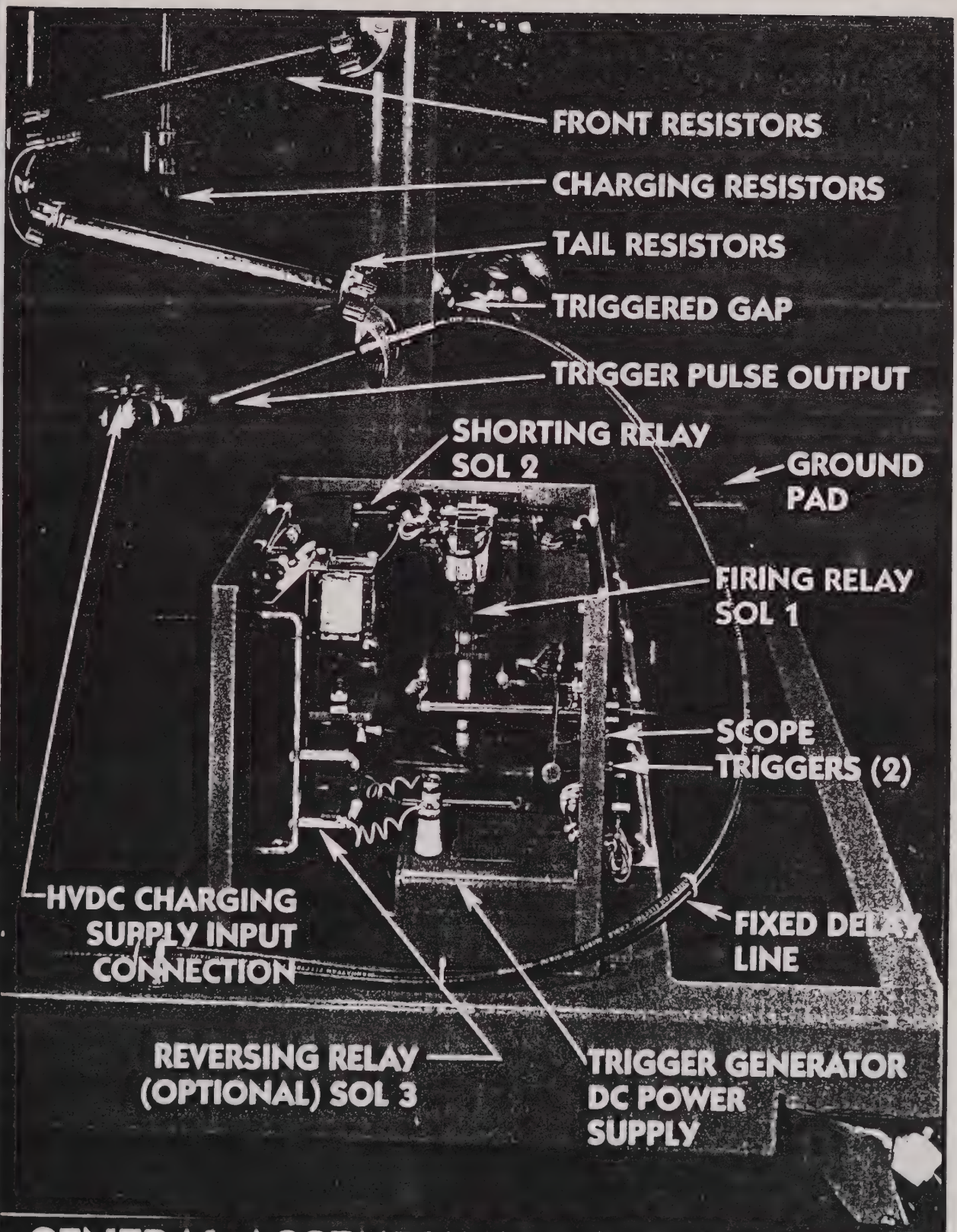

GENERAL ASSEMBLY 100 SERIES BASE

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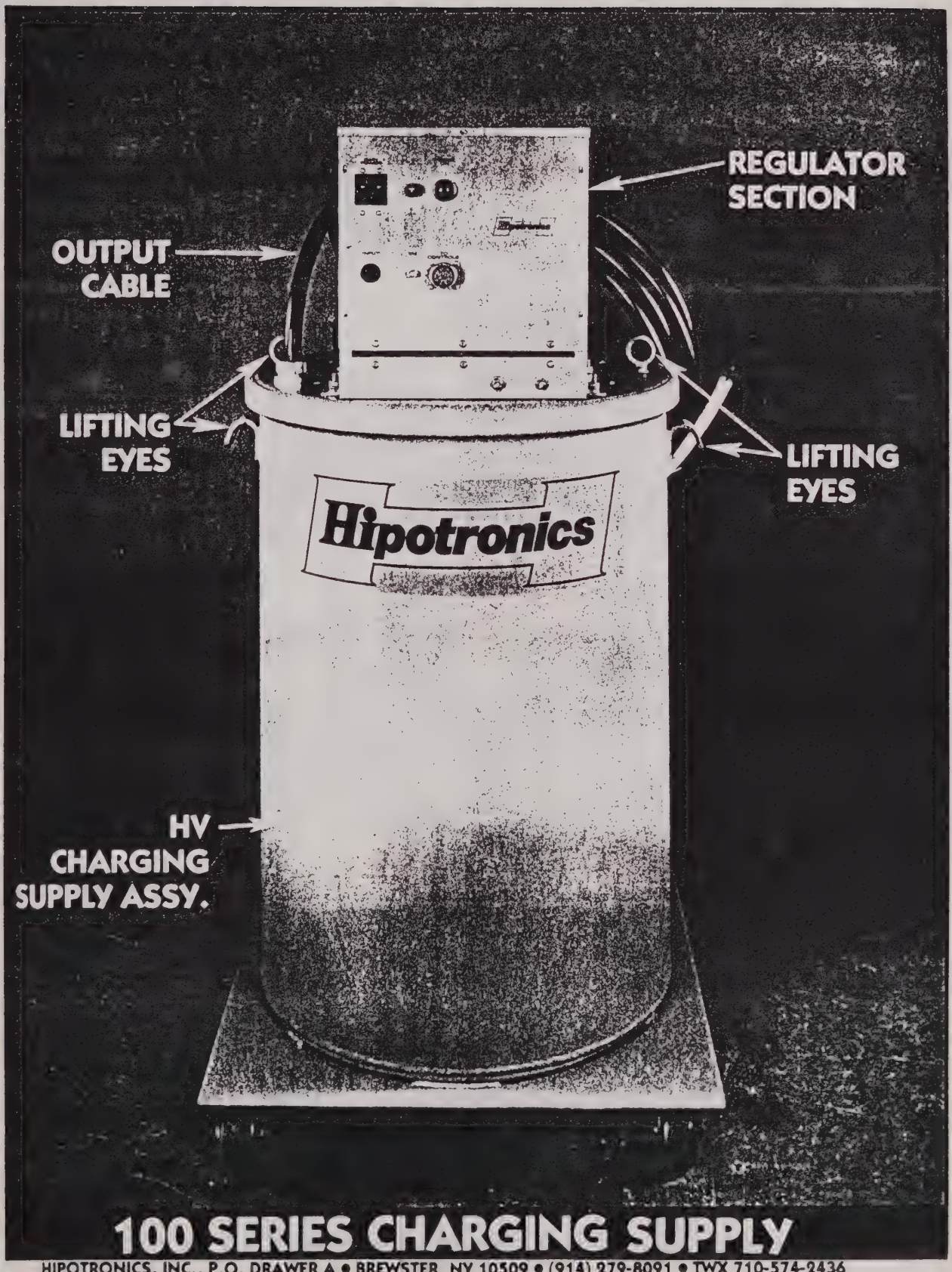

100 SERIES CHARGING SUPPLY

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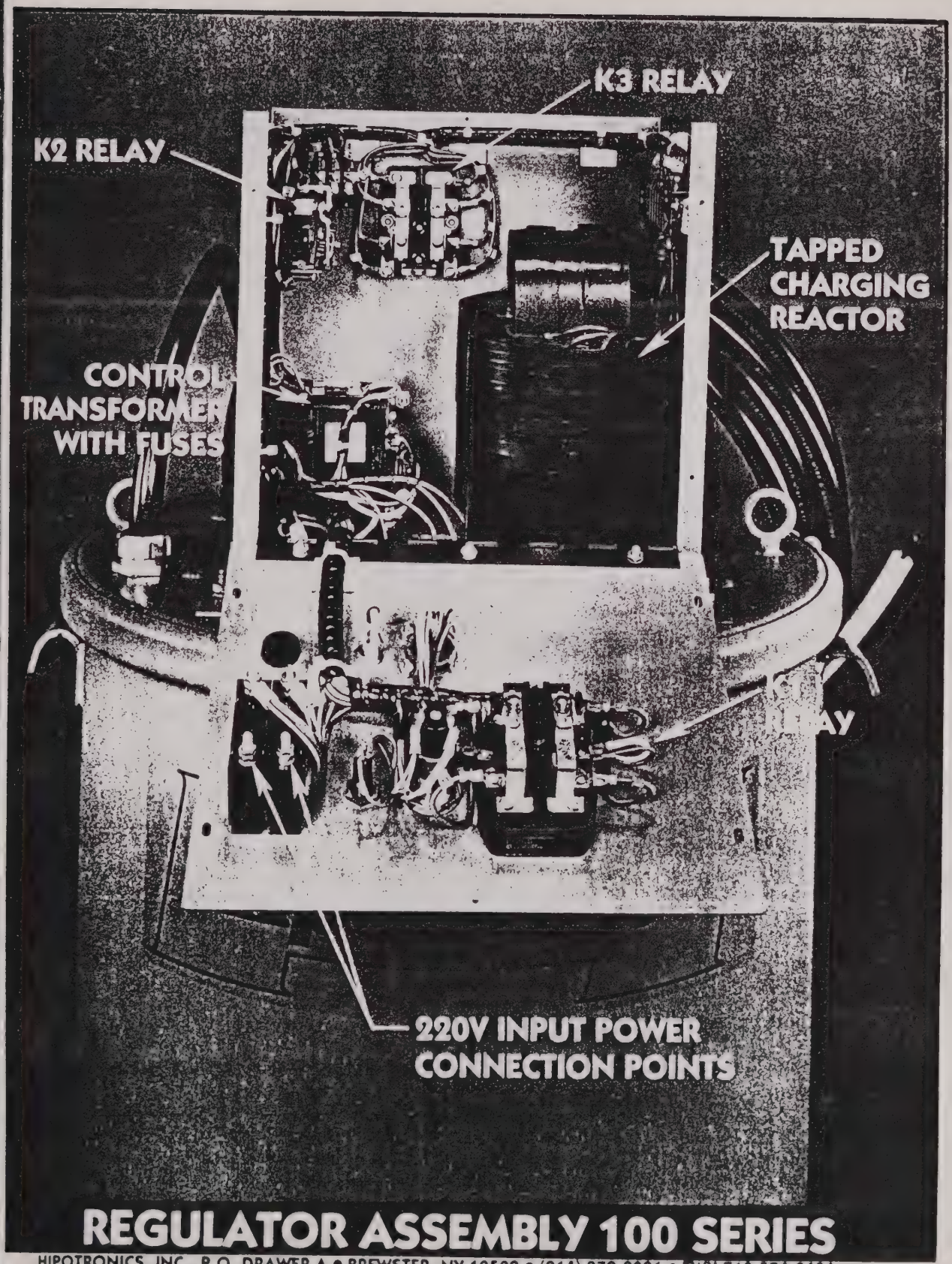

REGULATOR ASSEMBLY 100 SERIES

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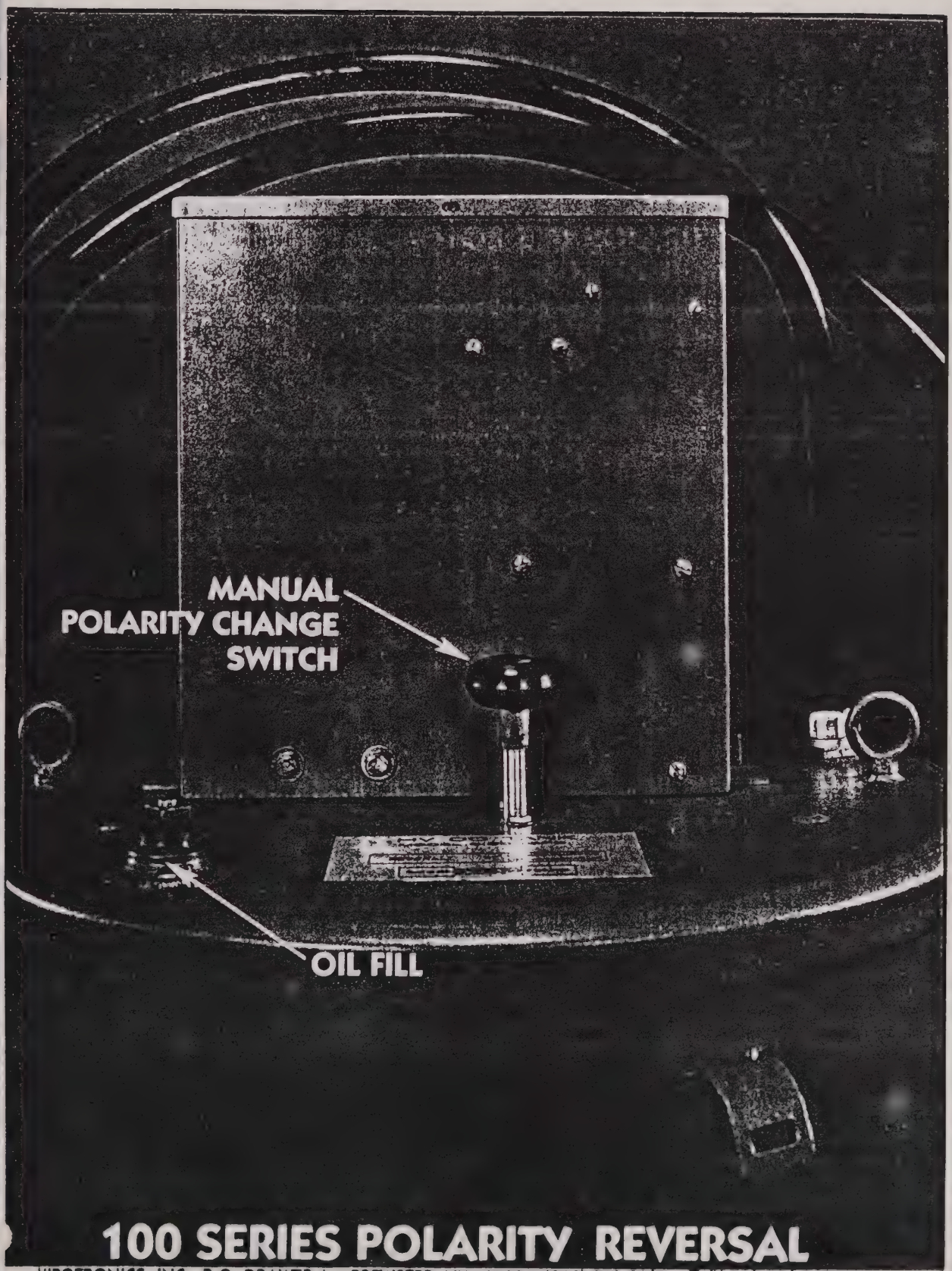

100 SERIES POLARITY REVERSAL

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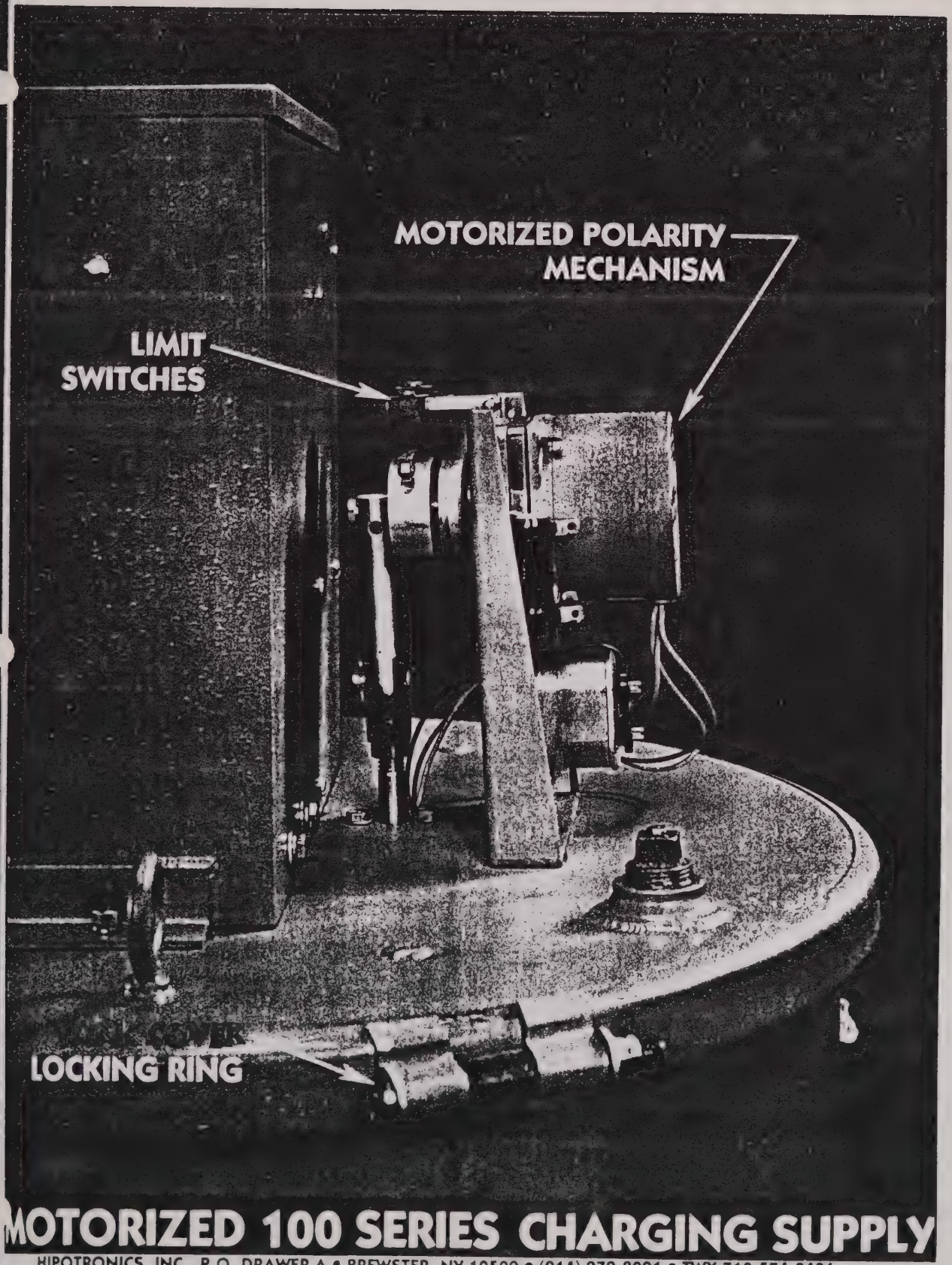

MOTORIZED 100 SERIES CHARGING SUPPLY

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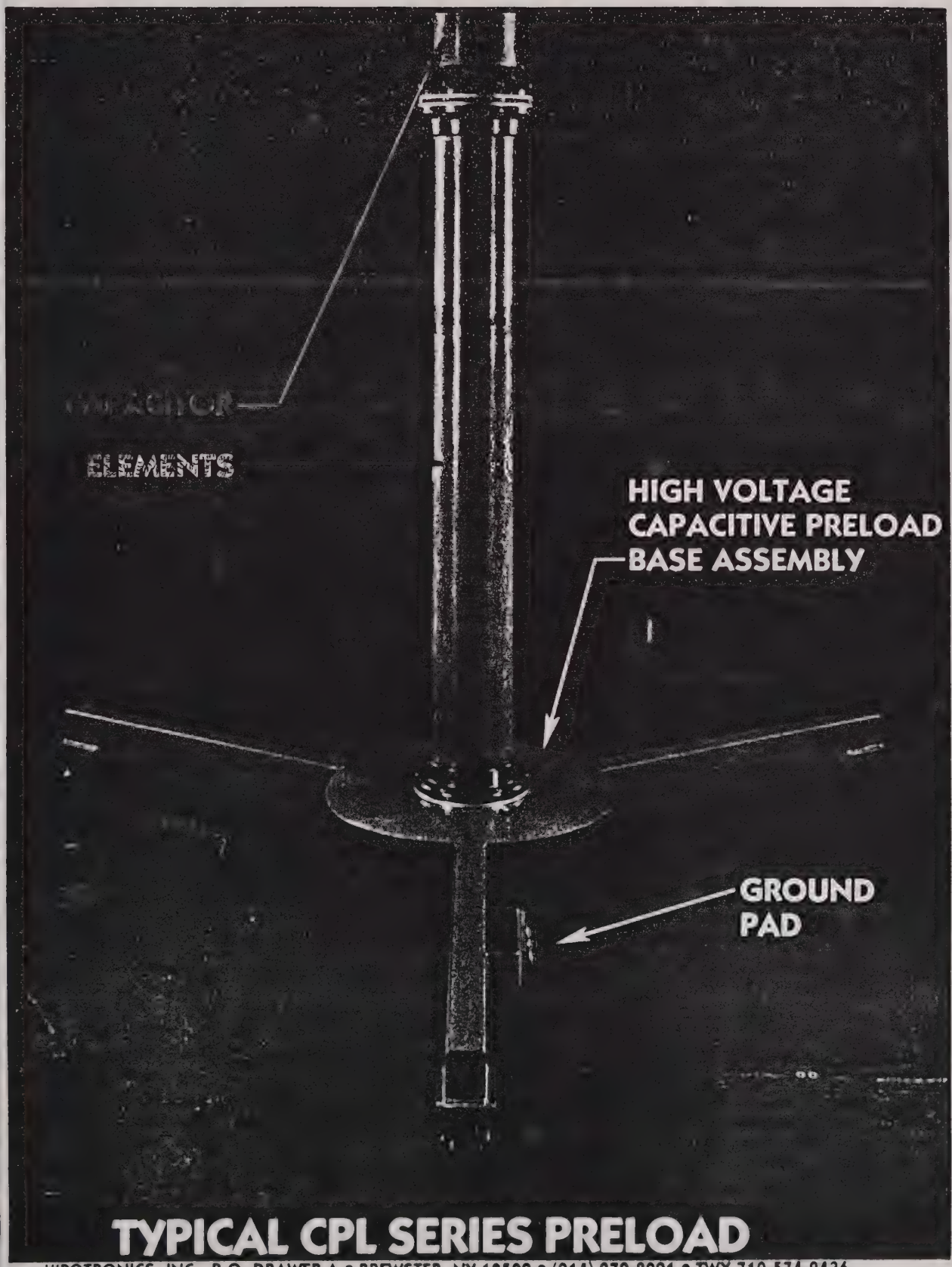

TYPICAL CPL SERIES PRELOAD

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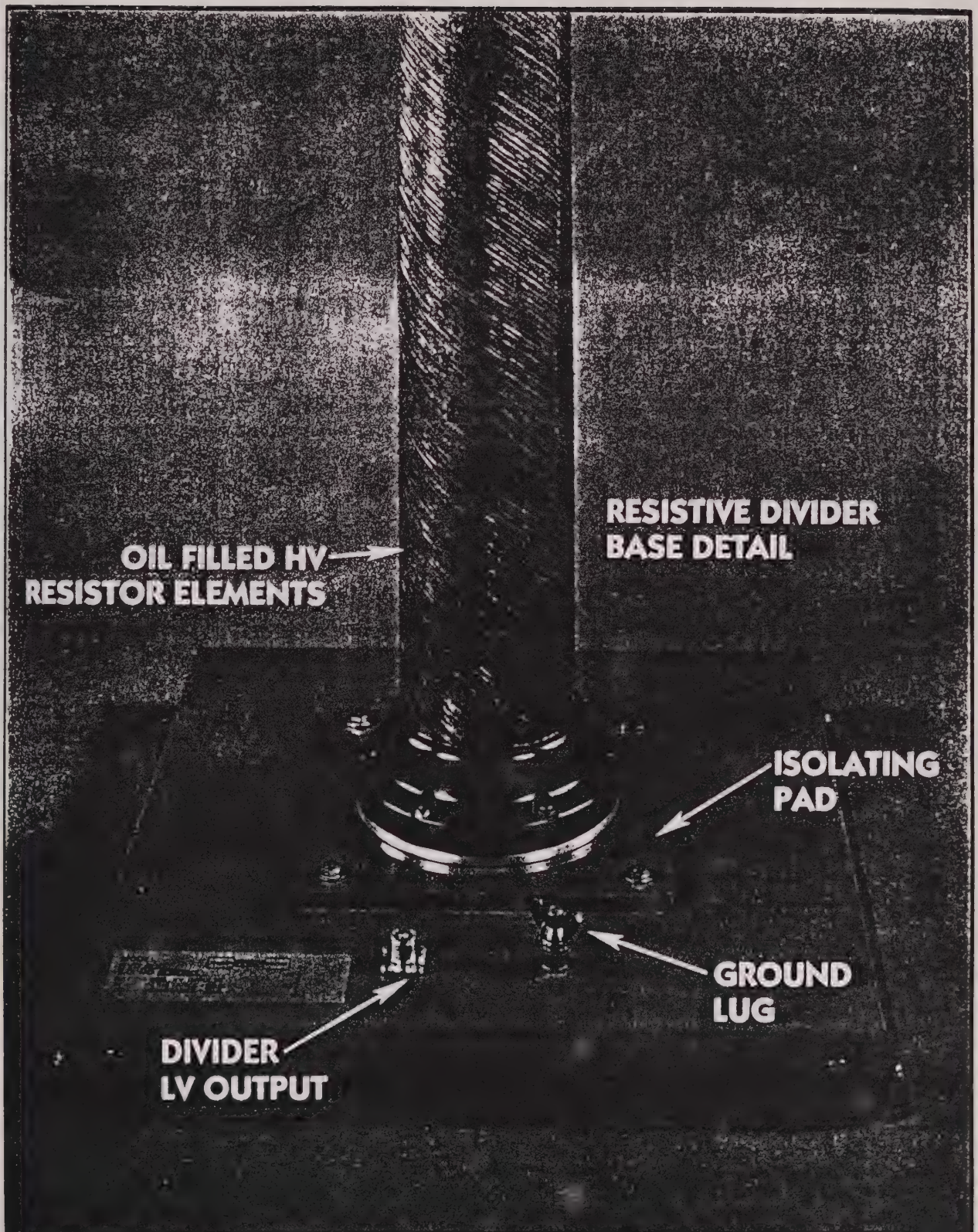

TYPICAL RVD SERIES VOLTAGE DIVIDER

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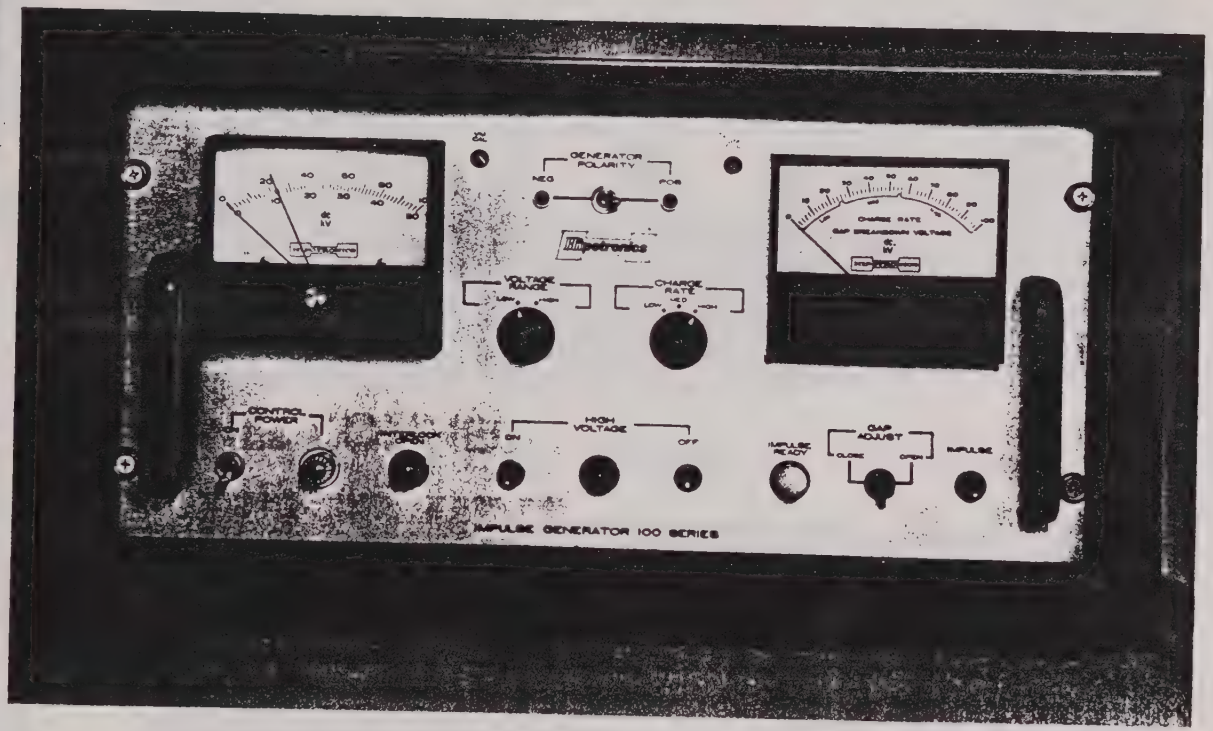

CONTROL MODULE

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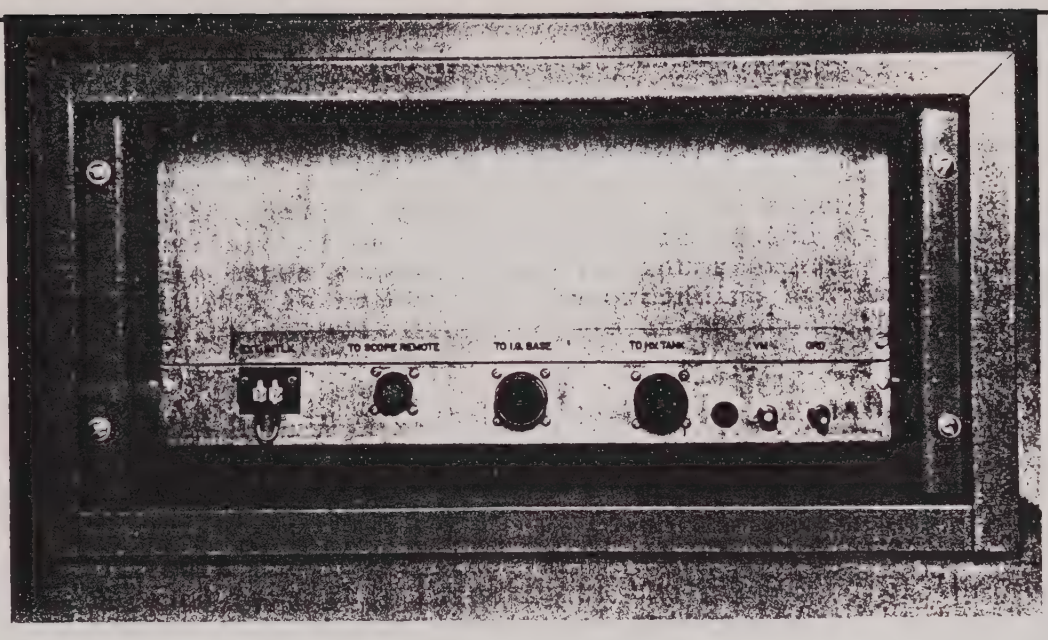
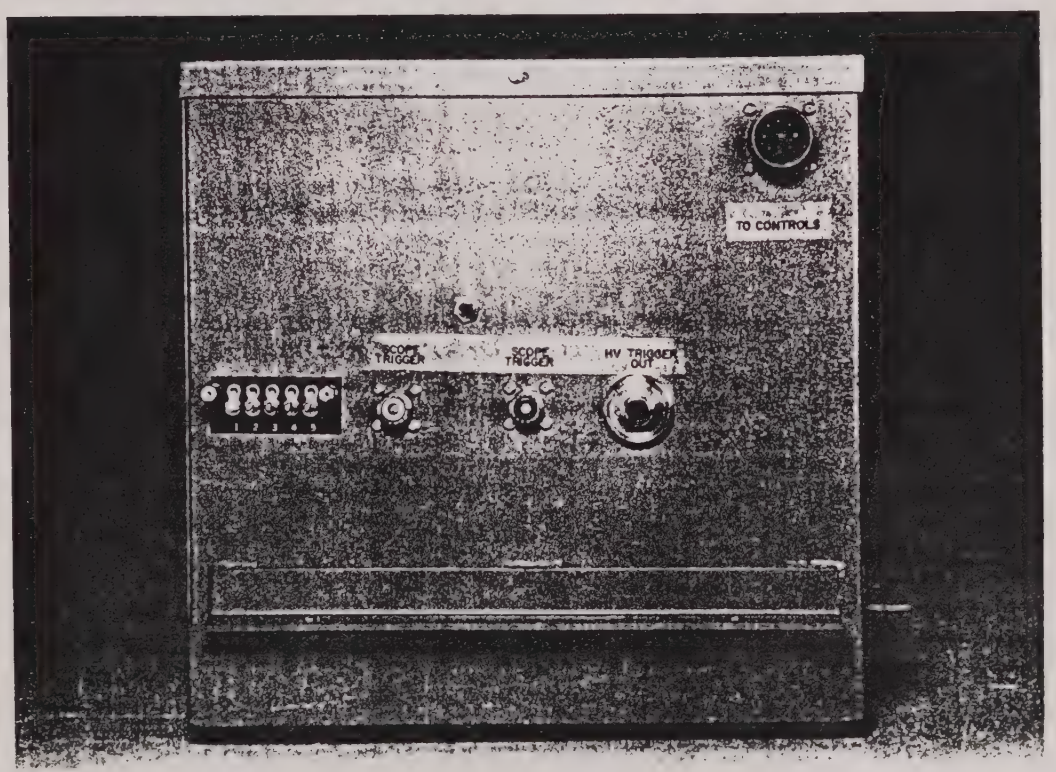


REAR PANEL CONNECTIONS IN CONTROL MODULE



INTERCONNECTIONS FACILITIES ON PULSE TRIGGERING MODULE

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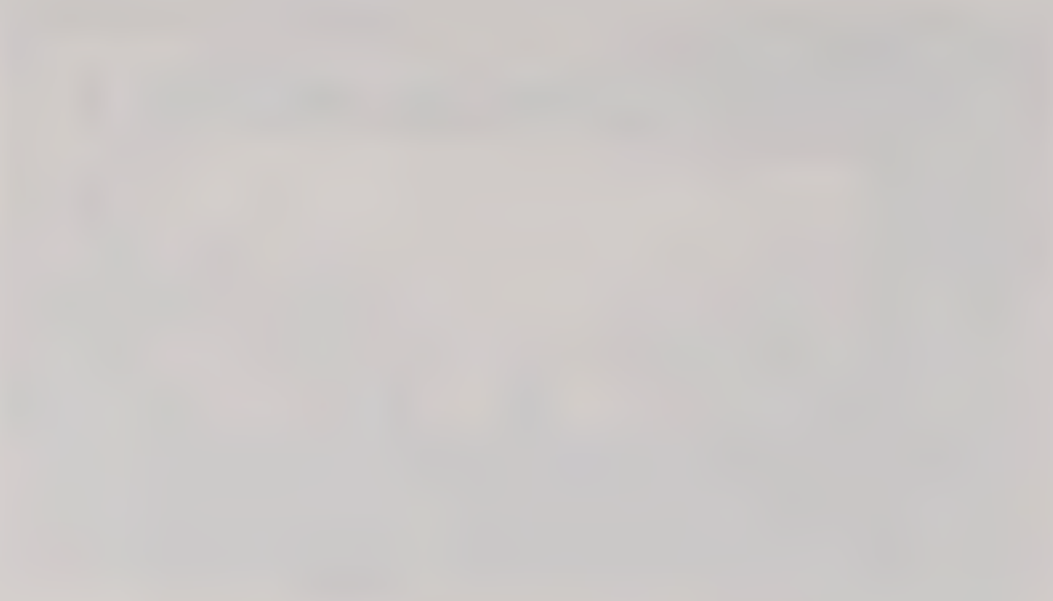
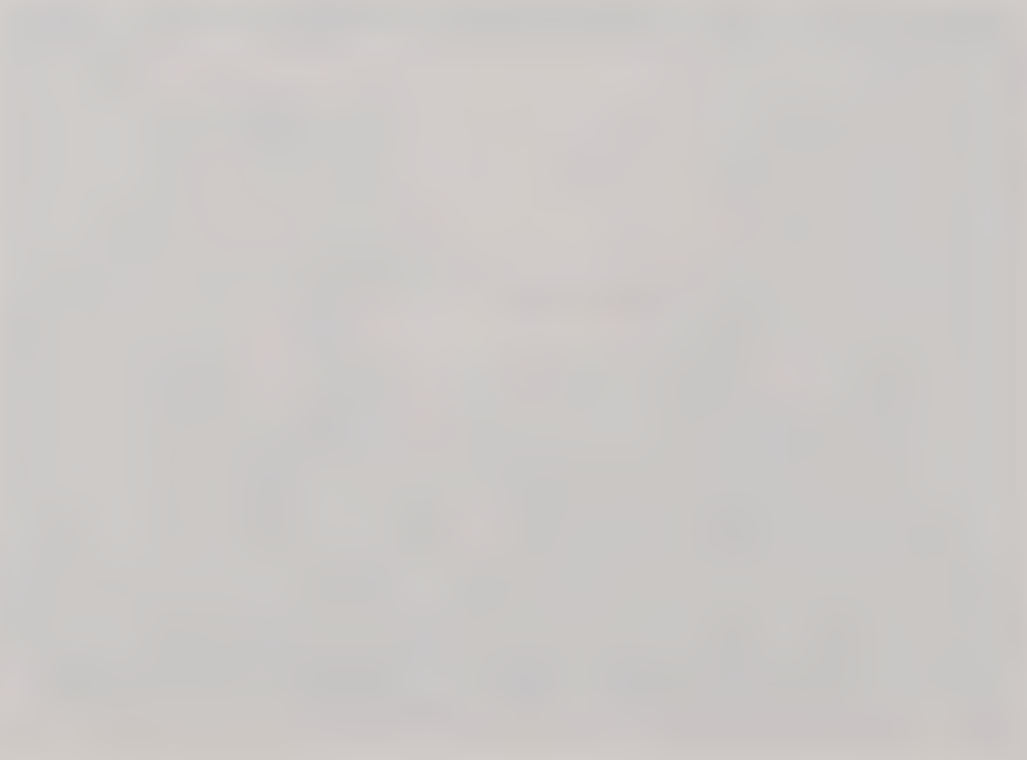




THE TRACING OF INTERFERENCE SOURCES

The grounding system, impulse generator, test object, voltage divider, measuring cables and measuring equipment may each constitute the source of interference. To establish the origin of the interference merely on the basis of its appearance requires considerable experience. As a rule interference with a frequency of about 10 MHZ is related to the grounding system, while interference having a lower frequency is associated with the high-voltage side.

A few simple and in most cases effective methods of revealing the origin of the interference will be described in the following.

MEASURING EQUIPMENT

Short-circuit the low-voltage arm of the voltage divider. If the interference persists, investigate the grounding of the cables and connection. In simpler installations it may be necessary to separate the conductors of the operating equipment and the oscillograph and to provide the oscillograph power supply with a network filter.

Hipotronics generators provide the oscillograph with a triggering unit, which irrespective of the amplitude and shape of the incoming signal transmits to the oscillograph a rapid impulse of determined amplitude.

In general best results are found by using wide copper foil (12" wide x 20 mill) from the divider directly to the oscilloscope.

TEST OBJECT

Partial discharges or oscillations may arise in the test object during the front time and these will appear on the screen as interference. This can be checked through the disconnection of the test object from the impulse testing circuit. When this has been done, an impulse wave free from interference should be obtained.

RECOMMENDED GROUNDING SYSTEM

Differences in the system grounding impedances can give rise to considerable variations in potential between the various components and also between the equipment and the network to which it has been connected. For this reason, a common protection must be adopted.

The best grounding system has proved to be a fully screened room. The floor screen, which has to serve as a return for the impulse current may consist of copper or aluminum sheet with a thickness of 2-3 mm. It should be mentioned, however, that a sheet metal floor owing to its exposed position is constantly subjected to severe mechanical stresses, which lead to cracks and irregularities.

A more practical solution is to embed a netting of copper sheet in a cement floor. The ground connections can be made with a suitable number of risers spread out along the floor and galvanically connected to the netting.

The walls and ceiling can be screened with wire netting having a mesh of about 25 x 25 mm. The screens must be joined together by soldering or welding at numerous points so that arbitrary current paths can be connected up any where in the screen.

In addition, any objects which can pick up voltage, such as drains, pipes for water, miscellaneous sockets, vessels etc. must be carefully connected to the screen. Naturally, it is not always possible to take such comprehensive measures. Simpler methods must often be adopted particularly for temporary installations. An acceptable solution is to use strips of nonnagnetic material about 33 mm wide and a few tenths of a millimeter thick which are laid out so as to form suitable current paths.

In the two grounding systems described above, it is extremely important that the circuit components should be arranged in as favorable a way as possible.

The network terminal blocks, main circuit breaker and all conductors up to the network side of the transformer are insulated for 10 kV relative to the cubicle body, i.e. to the impulse ground with at least 10 kV. The section of the cable nearest the grounded floor of the test site can be suitably insulated with a plastic hose having a wall thickness of 3 to 4 mm. The cubicle is set up adjacent to the generator and grounded to the ground system of the test site.

The location of the control room in relation to the impulse testing equipment is shown in Figures 16 A-C.
It is preferable to fully screen the room and reinforce the windows and doors with metal netting. Care must also be taken to see that the reinforcement is connected to the rest of the screen.

In simpler installations, the control and measuring equipment must be connected to the impulse ground. If metal strip is used as the ground conductor, the strip can be connected directly to the equipment.

The control cables for permanently installed equipment must have a grounded screen at both ends. If possible, the cables should be laid in a cable duct as shown in Fig. 14.

Only coaxial cables are used for measuring impulse voltages and impulse currents. The measuring cables can be laid under the metal floor in copper conduits emerging in a pit so as to avoid parasitic currents. In the pit the cables are connected to coaxial terminals.

A suitable number of cable pits with associated ducts, strategically arranged over the test site, will allow the measuring equipment to be connected up with the shortest possible lengths of measuring cable.

If the comprehensive procedure described above cannot be adopted, the measuring cables may be placed on the floor, possibly in copper conduits. As short lengths of cable as possible should be used.

EQUIPMENT INSTALLATION

A normal impulse voltage circuit is comprised of an impulse generator, a front capacitor, a front resistor, a tail resistor, a test object, voltage divider and oscilloscope. A schematic diagram of these components is contained in this manual.

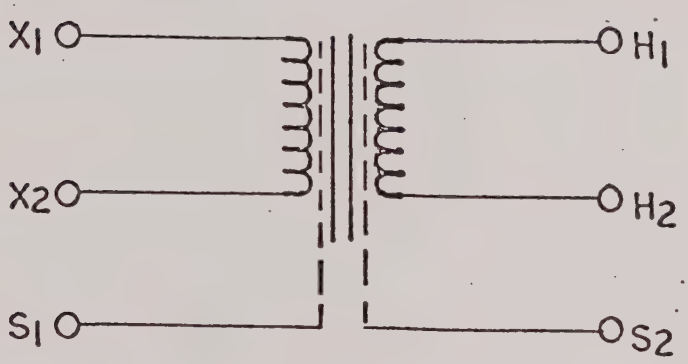
If it is assumed that the test object will withstand the impressed voltage, the maximum current load will arise between points 0-1 or 0-2 as shown in Figure 15. The earth current then decays gradually. If a breakdown or flashover occurs in the test object, point 2 will make the largest current contribution.

The voltage across the test object has to be measured with a voltage divider. It is therefore important that points 2 & 3 in Fig. 15 should have the same potential which also applies to points 3-4.

A logical lay out of the equipment will thus follow in principle the linear arrangement shown in the schematic diagram. A block diagram of the equipment is illustrated in Fig. 16 A which also includes the current paths as well as the location of an impulse chopping sphere gap when this is required. If metal strips are used as ground conductors, these must be placed in the current paths. The system is grounded at the generator.

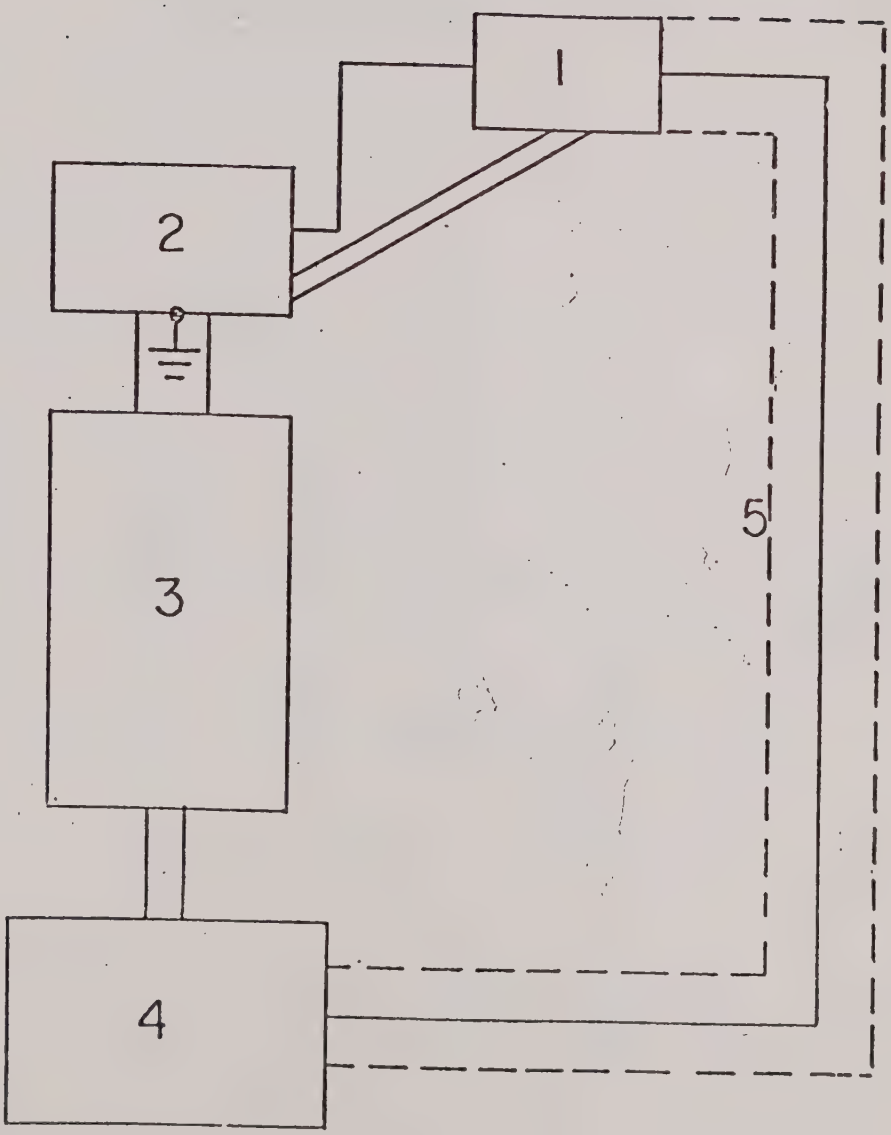
For reasons of space, it is not always possible to follow the recommendations given above. Two alternative proposals have been outlined in Figures 16B & 16C. It should be mentioned that the apparatus must be grounded with short conductors having a considerable cross sectional area, for example, a maximum length of about 500 mm and a minimum cross sectional area of about 70 mm^2.

As has already been mentioned, the differences between the ground impedances will give rise to overvoltages between the equipment and the network to which the equipment has been connected. The network and equipment must therefore be mutually protected with the aid of isolation transformers having screened windings. It is important that all supply leads are brought into the test site via isolation transformers having screened windings. All supply leads should be brought into the test site via the isolation transformers.



X1,X2	=	Input Primaries
S1,S2	=	Shields
H1,H2	=	Output

FIG. 13 Schematic showing design and connection of isolation transformer



1. Power Regulator/H.V. supply
2. Impulse generator
3. Impulse circuit
4. Control room
5. Control cables in cable duct

FIG. 14 Recommended control cable wiring

A. Impulse Generator
B. Front Capacitor
C. Front Resistor
D. Parallel Resistor
E. Test Object
F. Voltage Divider
G. Oscillograph

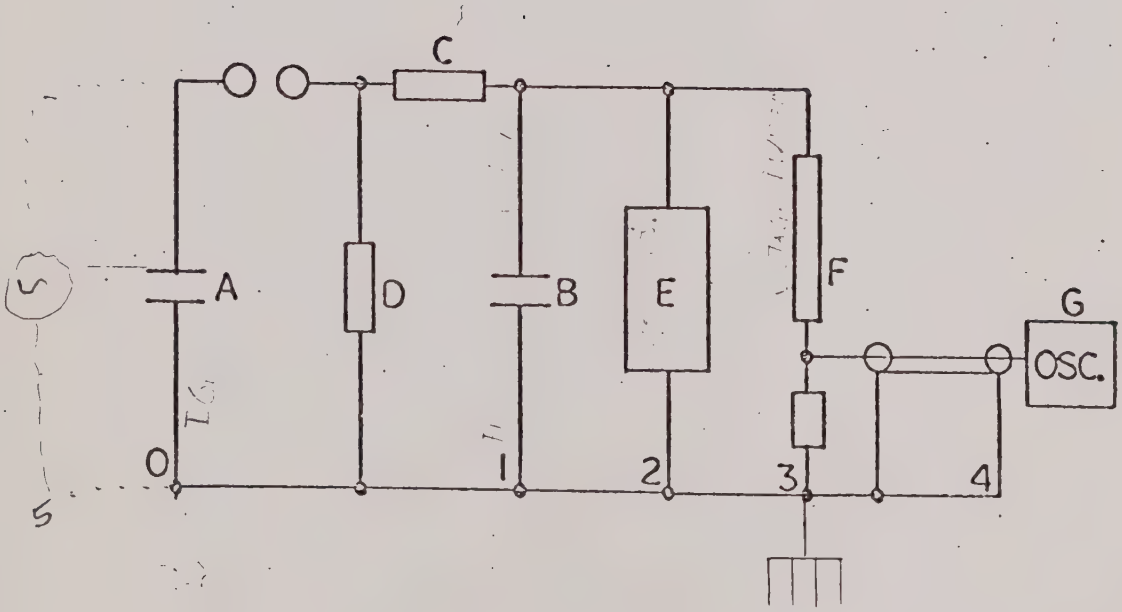


FIG. 15 Schematic of impulse equipment

RATED OUTPUT

Total Number of Stages 2
Maximum Voltage per Stage 100
Total Energy Stored per Stage 2.5 Kilojoules

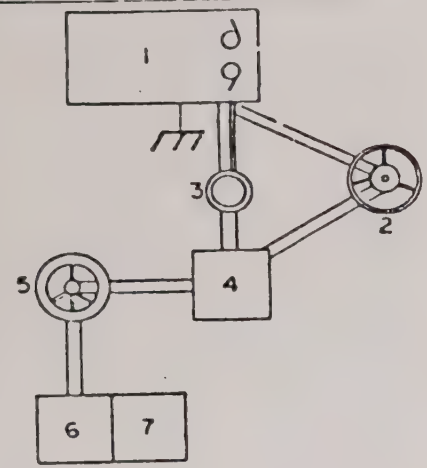
Number of Stages in Series	Number of Stages in Parallel	Maximum Output Voltage (Kilo-volts)	Maximum Stored Energy (Kilo-joules)	Net Generator Capacitance (Nanofarads)	Maximum Load* (Pico-farads)	Number of Gaps Used
2	1	200	5	250	75nF	2
1	2	100	5	1000	300nF	1

*Maximum load without drastically affecting efficiency

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED

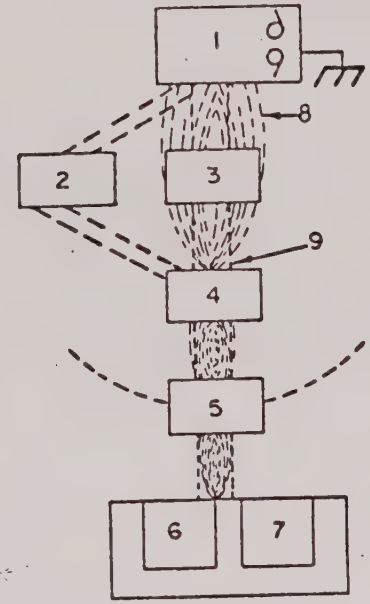
A

LAY-OUT AND EARTHING OF IMPULSE CIRCUIT



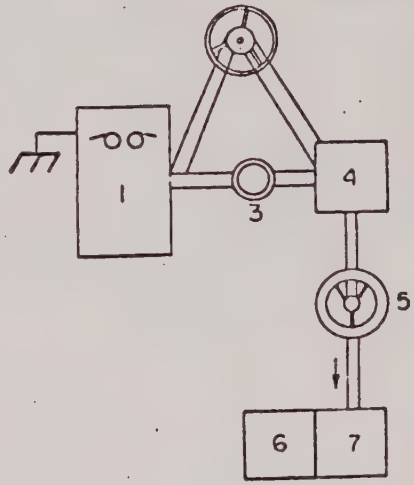
B

LAY-OUT AND EARTHING OF IMPULSE CIRCUIT



C

LAY-OUT AND EARTHING OF IMPULSE CIRCUIT



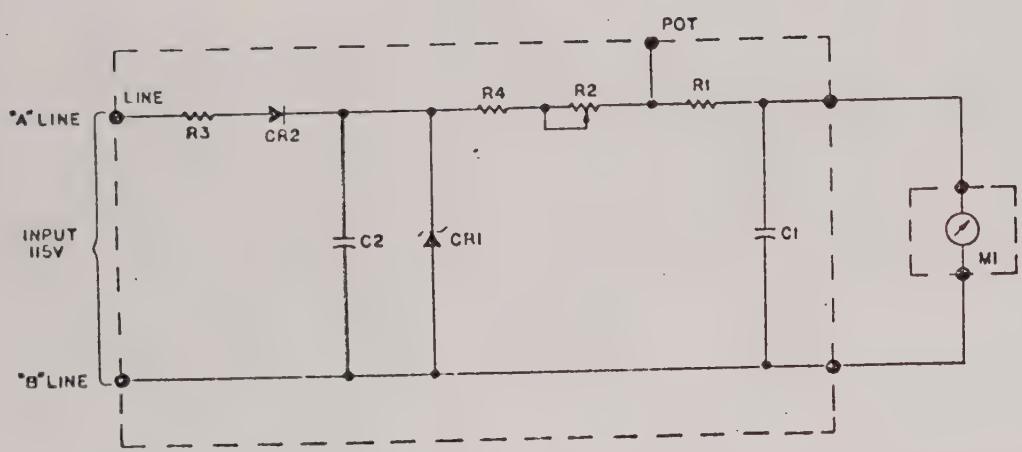
LEGEND

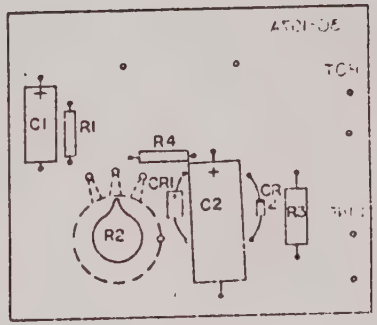
1. IMPULSE GENERATOR
2. CHOPPING GAP
3. FRONT CAPACITOR
4. TEST OBJECT
5. VOLTAGE DIVIDER
6. CONTROL DESK
7. OSCILLOGRAPH
8. CURRENTS PATH
9. METAL STRIP (FOIL)

QTY	DESCRIPTION	PART NO.	MAT'L OR NOTE	ITEM
	FIG. 16 RECOMMENDED LAYOUTS OF IMPULSE CIRCUIT			

HIPOTRONICS
BREWSTER, N.Y.

MAT'L	NEXT ASSY	MODEL NO STND. 165	SERIAL NO
FINISH	UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES DO NOT SCALE DWG TOLERANCES	DRAWN F.R. 4-7H	DWG NO. BI25-339 REV.
	FRACTIONS DECIMALS ANGLES	CHECKED	
		APPROVED 4-7H	SCALE





NOTE:
FOR IMPULSE GENERATOR;
R1 IS 10K, ½W
R4 IS NOT USED

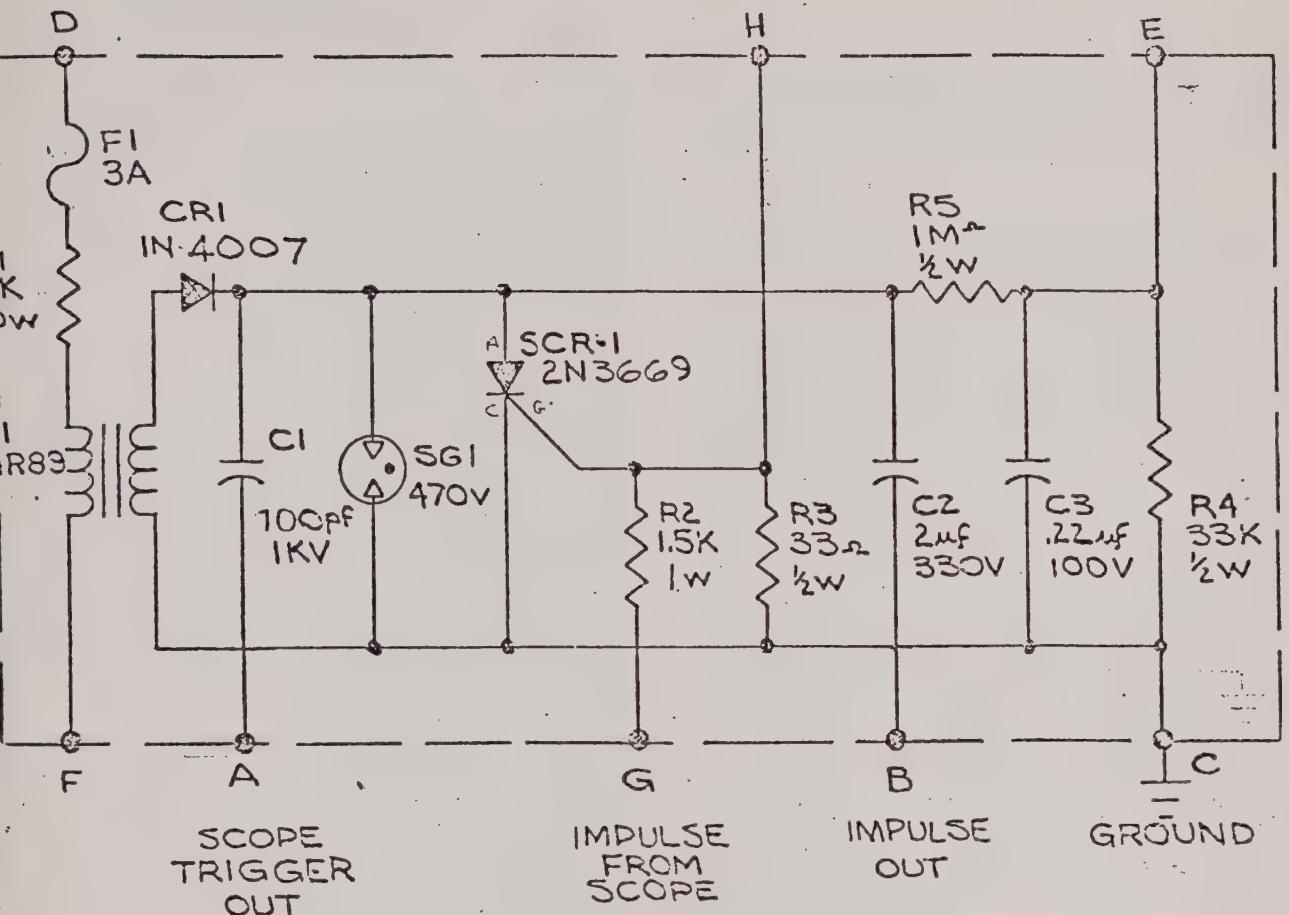
QTY	DESCRIPTION	PART NO	MATL OR NOTE	ITEM
1	RESISTOR	20K, ½W, 1%	R1	8
1	"	20K, 1W, 1%	R4	7
1	"	25K, 10 TURN POT, 2W	R2	6
1	"	10K, 1W, 10%	R3	5
1	DIODE	IN4007	CR2	4
1	DIODE ZENER	IN3037B	CR1	3
1	CAPACITOR	60UF, 50V	C1	2
1	"	16UF, 150VDC	C2	1

GAP METER
P.C.B

HIPOTRONICS
BREWSTER, N.Y.

MATL				
FINISH	UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES DO NOT SCALE DWG TOLERANCES	DRAWN FRED 1-80	DWG NO CD30-197	REV A
			SCALE	

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
A	INCORP. EC 37-1024	2/[illegible]/72	[illegible]



PULSE TRIGGERING CKT

HIPOTRONICS
BREWSTER, N.Y.

NEXT ASSY		MODEL NO: IMPULSE GENERATOR	PULSE FIRING CIRCUIT
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES DO NOT SCALE DWG TOLERANCES	DRAWN [illegible] DATE	DWG NO. AF30-227-1	REV A
	CHECKED [illegible] 10/3/71		
FRACTIONS ±1/64 / DECIMALS ±.005 / ANGLES ±30'	APPROVED [illegible] 11/5/74	SCALE	SHT 1 OF 1

WARRANTY

HIPOTRONICS, INC. warrants to the original purchaser of any new merchandise that the merchandise is free from defects in material and workmanship under normal use and service for a period of one (1) year from the date of shipment. The obligation of Hipotronics, Inc. under this Warranty is limited, in its exclusive option, to repair, replace or issue credit for parts or materials which prove to be defective, and is subject to Purchaser's compliance with the Hipotronics, Inc. Warranty Claim Procedure as set forth below. The happening of any one or more of the following events will serve to void this Warranty and any defect or damage resulting therefrom is specifically excluded from Warranty coverage: (a) defects due to accident, negligence, alteration, modification, faulty installation, abuse or misuse by Purchaser or Purchaser's agents or employees; (b) attempted or actual dismantling, disassembling, service or repair by any person, firm or corporation not specifically authorized in writing by Hipotronics, Inc.; (c) defects caused by or due to handling by carrier, or incurred during shipment, transshipment or other move.

This Warranty covers only those parts and/or materials deemed by Hipotronics, Inc. to be defective within the meaning of this Warranty. The liability of Hipotronics, Inc. shall be limited to the repair, replacement or issuance of credit for parts deemed defective within the meaning of this Warranty. Costs incurred by purchaser for labor or other expenses incidental to the inspection, repair, replacement or issuance of credit for such parts and/or material shall be the sole responsibility of purchaser. This Warranty shall not apply to any accessories, parts, or materials not manufactured or supplied by Hipotronics, Inc. and if, in the sole discretion of Hipotronics, Inc., Purchaser's claim relates to any materials or workmanship manufactured or performed by the supplier of a component part, or of the manufacturer of a device of which the defective part is a component, Hipotronics, Inc. reserves the right to disclaim liability under this Warranty and to direct that the Purchaser deal directly with such supplier or manufacturer. Hipotronics, Inc. agrees to assist the purchaser in processing or settling any such claim without prejudicing its position as to liability.

WARRANTY CLAIM PROCEDURE Compliance with the following Warranty Claim Procedure is a condition precedent to the obligation of Hipotronics, Inc. under this Warranty:

(a) Purchaser must notify Hipotronics, Inc. in writing by certified or registered mail, of the defect claimed within twelve (12) months after date of original shipment. Said notice shall describe in detail the defect, the defective part, and the alleged cause of defect; (b) at the exclusive option of Hipotronics, Inc., Purchaser shall dismantle or disassemble at Purchaser's cost and expense and shall ship the defective part or material prepaid to Hipotronics, Inc., Brewster, New York 10509, for inspection, or permit an authorized service representative of Hipotronics, Inc. to inspect the defective part or material at Purchaser's premises. If Hipotronics, Inc. shall inspect the part or material at the Purchaser's premises, Purchaser shall provide facilities for, and at Purchaser's cost and expense, dismantle, disassemble, or otherwise make accessible the subject part or material whether or not same is a component of or installed in a device other than that manufactured or supplied by Hipotronics, Inc. If disclosure shows that the defect is not one for which Hipotronics, Inc. is liable, the Purchaser agrees to reimburse Hipotronics, Inc. for all expense incurred; (c) upon receipt of the defective part or material, or after access to same, Hipotronics, Inc. shall inspect the part or material to determine the validity of Purchaser's claim.

The validity of any Warranty Claim, Purchaser's compliance with Hipotronics, Inc. Warranty Claim Procedure, the obligation to either repair, replace, or issue credit, or direct the purchaser to deal directly with a manufacturer or supplier are to be determined solely and exclusively by Hipotronics, Inc. and any determination so made shall be final and binding.

THIS WARRANTY IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES EXPRESSED OR IMPLIED ON THE PART OF HIPOTRONICS, INC., INCLUDING THE WARRANTIES OF MERCHANTIBILITY AND FITNESS FOR USE, AND CONSEQUENTIAL DAMAGES ARISING FROM ANY BREACH THEREOF AND HIPOTRONICS, INC. NEITHER ASSUMES NOR AUTHORIZES ANY OTHER PERSON, FIRM OR CORPORATION TO ASSUME ANY LIABILITY OR OBLIGATION IN CONNECTION WITH THIS SALE ON ITS BEHALF AND PURCHASER ACKNOWLEDGES THAT NO REPRESENTATIONS EXCEPT THOSE MADE HEREIN HAVE BEEN MADE TO PURCHASER.

RETURNED MATERIAL FORM

If, for any reason, it should become necessary to return the equipment described in this publication to the factory, the Warranty Service Department of HIPOTRONICS must be contacted, at which time the following data must be given in order that we may identify the unit and determine the necessity for return. [Tel. (914) 279-8035] MODEL, SERIAL NO. and TYPE (Part No.) is indicated on the black and silver tag affixed to the unit.

MODEL: _____

SERIAL NUMBER: _____

TYPE (Part No.): _____

REASON FOR RETURN: _____

DEFECT: _____

ALLEGED CAUSE OF DEFECT: _____

If HIPOTRONICS deems return of the unit appropriate, an "Authorization for Return" tag will be issued. This will instruct you as to the method of return. The pink copy is for your records, the hard copy to be affixed to the unit being returned. If return is not deemed advisable, other inspection arrangements will be made.

NOTE

Material received at this plant without the proper authorization shall be held as "customer's property," with no service performed until such time as the proper steps have been taken.

Your cooperation is requested in order to ensure prompt service. Thank you.

PARTS ORDERING

To order replacement parts for this unit, please refer to the Parts List contained in the pocket of this publication. The number of the specific component is required, along with the TYPE (Part No.) of the unit. The TYPE (Part No.) is indicated on your Parts List, and on the black and silver tag affixed to the unit.

PARTS LIST
MODEL NO. IG100 SERIES - STAGES
PART NO. DS25-457

CONTROLS

A1	Cabinet 19 x 8-3/4, Hipo
A2	Chassis & Cover D11-347-D011-348B, Hipo
A5	Front Panel 19 x 8-3/4 x 1/8 D124-25-001, Hipo
A6	Front Panel Handles VPC346, Vemaline
K1,2	Relay, PR11AN, DPDT, 120V, P&B
PL1-4	Pilot Light, 5100-832, Drake Pilot Light Bulbs, NE51H Pilot Light Lens 25P-323, Red,Yellow,White,Clear,Drake
M1	Meter Relay, 503K-50uA w/scale 0-50/100 kV, API
M2	Meter, 7045-50 uA w/scale 0-100 CM, API
R1,2	Resistor, Pot, 25 k, 2 W, Meter Adjust
R3	Resistor, 47 k, 2 W, Carbon
S1,2	Switch, Rotary, 2002,Centralab
S3	Switch, lever, 3037, Lev-R
S5,7	Switch, Pushbutton, P-27A
S6	Switch, Pushbutton, P-27L
S4	Switch, Toggle, 7565-K5
MOV1-3	Movistor, V130LA10A, G.E.
J1	Connector, MS3102A-20-16P, Amphenol
J2	Connector, MS3102A-20-16S, Amphenol
J3	Connector, MS3102A-14S-6S, Amphenol
J4	Connector, BNC, UG1094/U, Amphenol
PCB1	FAB, 30-409 & associated parts
R1,2	Resistor, 820 ohms, 2 W, Carbon
R3	Resistor, 1 k ohm, 2 W, Carbon
R4,5	Resistor, 100 k ohms, ½ W, 1%
R6	Resistor, 51 k ohms, 1 W, Carbon
C1	Capacitor, 16 uF @ 150 V
C2	Capacitor, 60 uF @ 25 V

CR1	Diode, 1N3037D
CR2	Diode, 1N4007

REGULATOR
PART NO. DS25-457

A1	DD25-252 HOUSING, Hipo
CB1,2	Circuit Breaker AM-A3-A, Heinemann
F1,2	Fuse, 05200475-5A, Buss
F3	Fuse, 05200525-10A, Buss
T1	Transformer, SV-4239, Hipo 240/220/208: 115 150VA
L1	Line Reactor, LV2677B, Hipo
PL1	Pilot Light, 75AP Pilot Light Lens 75A-101 Pilot Light Bulb, 6S6
MOV1	Movistor, V130LA10A, 130 V, G.E.
MOV2-7	Movisotr, V250LA40A, 250 V, G.E.
K1-3	Relay, PM11AY, DPDT, 120 V, P&B
J1	Connector, MS3102A-20-16S, Amphenol

CHARGING SUPPLY

CR1-4	Diode Rectifier, S-1520, Edal
R1,2	Resistor, 130 Meg, 10 W, 15%
R3,4	Resistor, 10 k ohms, 100 W
R5	Resistor, 250 k, 200 W
R6	Resistor, 150 Meg, 6 W
SOL-1	Solenoid, 14C, Guardian

PULSE UNIT
P/N DS25-457

A1	Housing, DD25-458, Hipo
J1	Connector, MS3102A-20-16S, Amphenol
C1,2	Capacitor, 100 pFd, 1 kV
R1	Resistor, 10 M, 6 W
R2	Resistor, 5 k, 25 W
R3	Resistor, 10 ohms, 2 W (20 in para)
R4,5	Resistor, 75 ohms, ½ W, Carbon
MOV2	Movistor, V130LA10A, 130 V, G.E.
T1	Transformer, PV4026, Hipo
SOL1	Solenoid, 14C, Guardian
SOL2	Solenoid, 9-297M, Decco
TB1	Terminal Board, 141-5

GENERATOR, BASE - 6 STAGE

CG1-6	Capacitor, .5 uF, 100 kV, MSAF-901-C310
RCH	Resistor, 20 k ohms, 200 W, Inductive
RT	Resistor, 500 ohms, 200 W, Non-Inductive
RT	Resistor, 1000 ohms, 200 W, Inductive
RF	Resistor, 150 ohms, 200 W, Non-Inductive
B1	Motor, SS50P3, Slo-Syn
R2	Resistor, 400 ohms, 25 W
C1	Capacitor, 2.75 uF 330 Vac
R1	Resistor, Pot., 1 k, 2 W
LS1,2	Switch, 2HBA-5, Upper & Lower

INTERCONNECTING CABLES

Connector	MS3106B-20-16P, Amphenol
Connector	MS3106B-20-16S, Amphenol
Connector	MS3106B-14-6S, Amphenol
Connector	MS3106B-14-6P, Amphenol
Cable Clamps	97-3057-12, Amphenol
Cable Clamps	97-3057-6, Amphenol
Connectors	UG88/U, Amphenol
Connectors	PL259, Amphenol
Cable	M1770, 16GA, Manhattan
Cable	M1706, 18GA, Manhattan
Cable	RG58/U, Manhattan
Cable	RG11/U, Manhattan

OPTIONAL MOTORIZED POLARITY

Controls

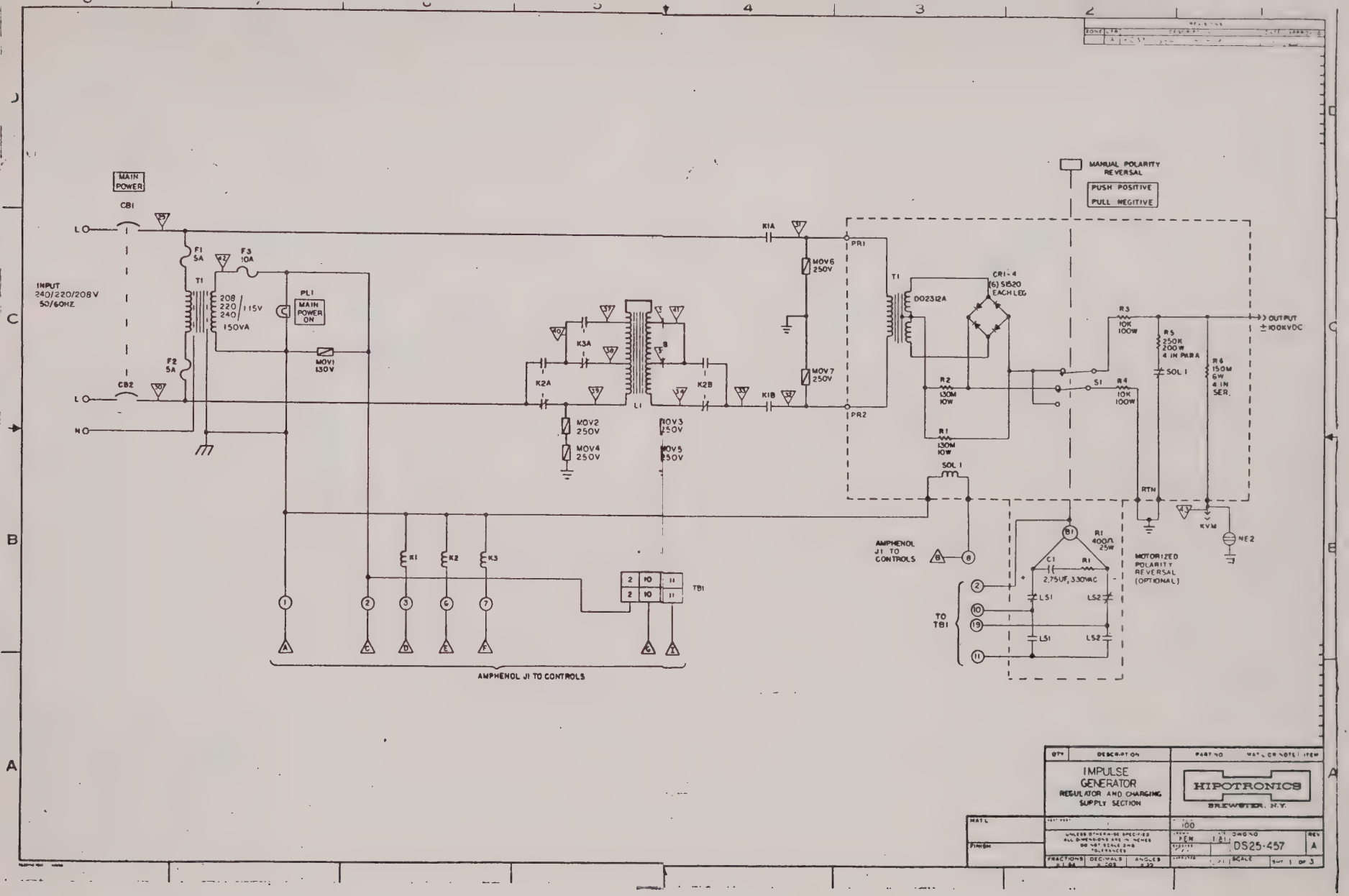
S8	Switch, toggle, 7565-K5
PL5,6	Pilot Light, 5100-832
	" " , Bulbs, NE51H
	" " , Lens , Blue-Red

Charging Supply

C1	Capacitor, 2.75 uF , 330 Vac
R1	Resistor, 400 ohms, 25 W
B1	Motor, SS50P3, Slo-Syn
LS1,2	Switch, 2HBA-5, Unimax

Pulse Unit

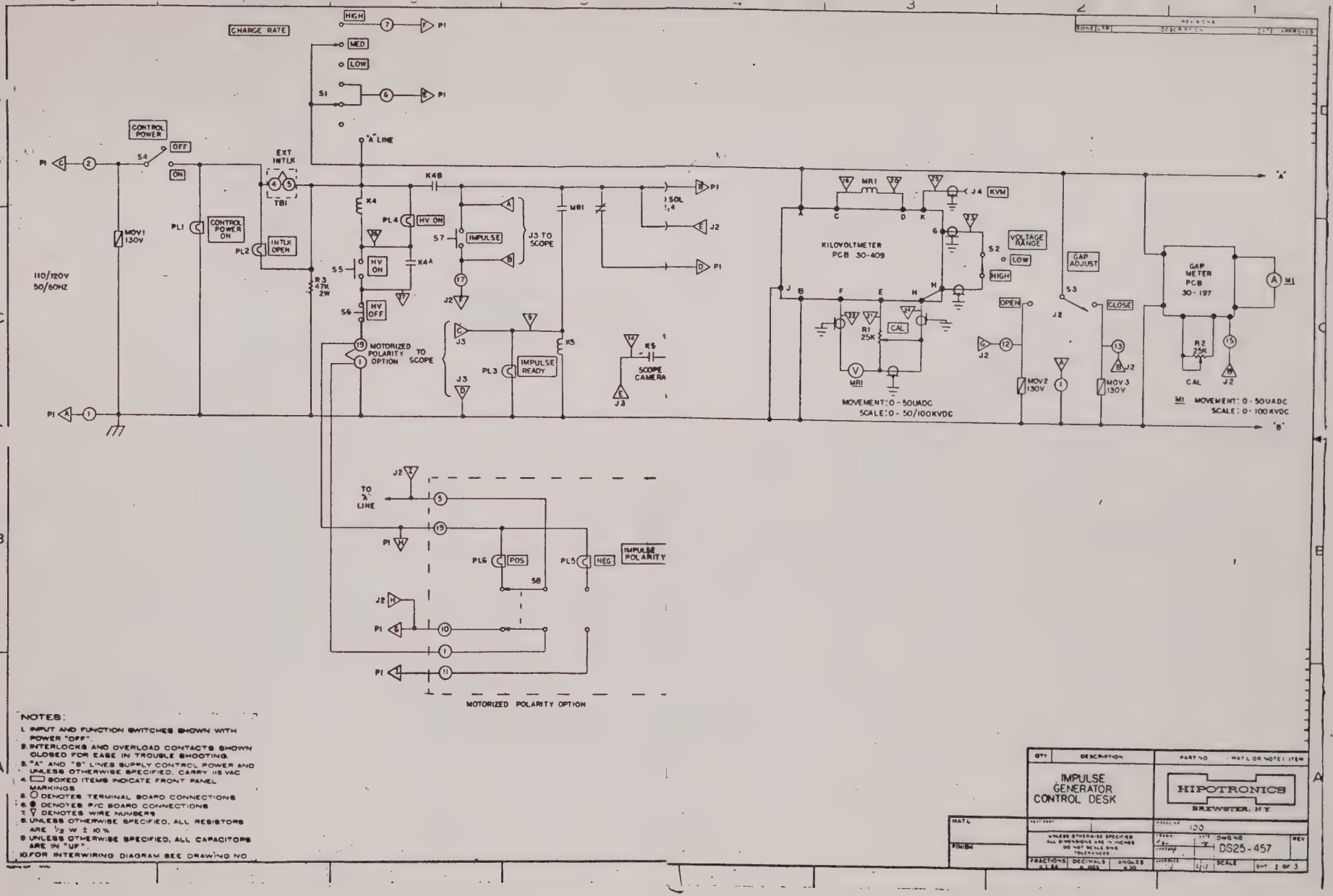
SOL3	Solenoid, 14C, Modified, Hipo Guardian
Q1	Transistor, MPSV10
K1	Relay, MK02D
C1	Capacitor, 16 uF , 250 V
C2	Capacitor, 4 uF 250 V
R1	Resistor, 1 Meg, ½ W, Carbon
R2	Resistor, 100 k, ½ W, Carbon
R3	Resistor, 220 ohms, ½ W, Carbon



QTY	DESCRIPTION	PART NO	MAT'L OR NOTE	ITEM
	IMPULSE GENERATOR REGULATOR AND CHARGING SUPPLY SECTION			

HIPOTRONICS
BREWSTER, N.Y.

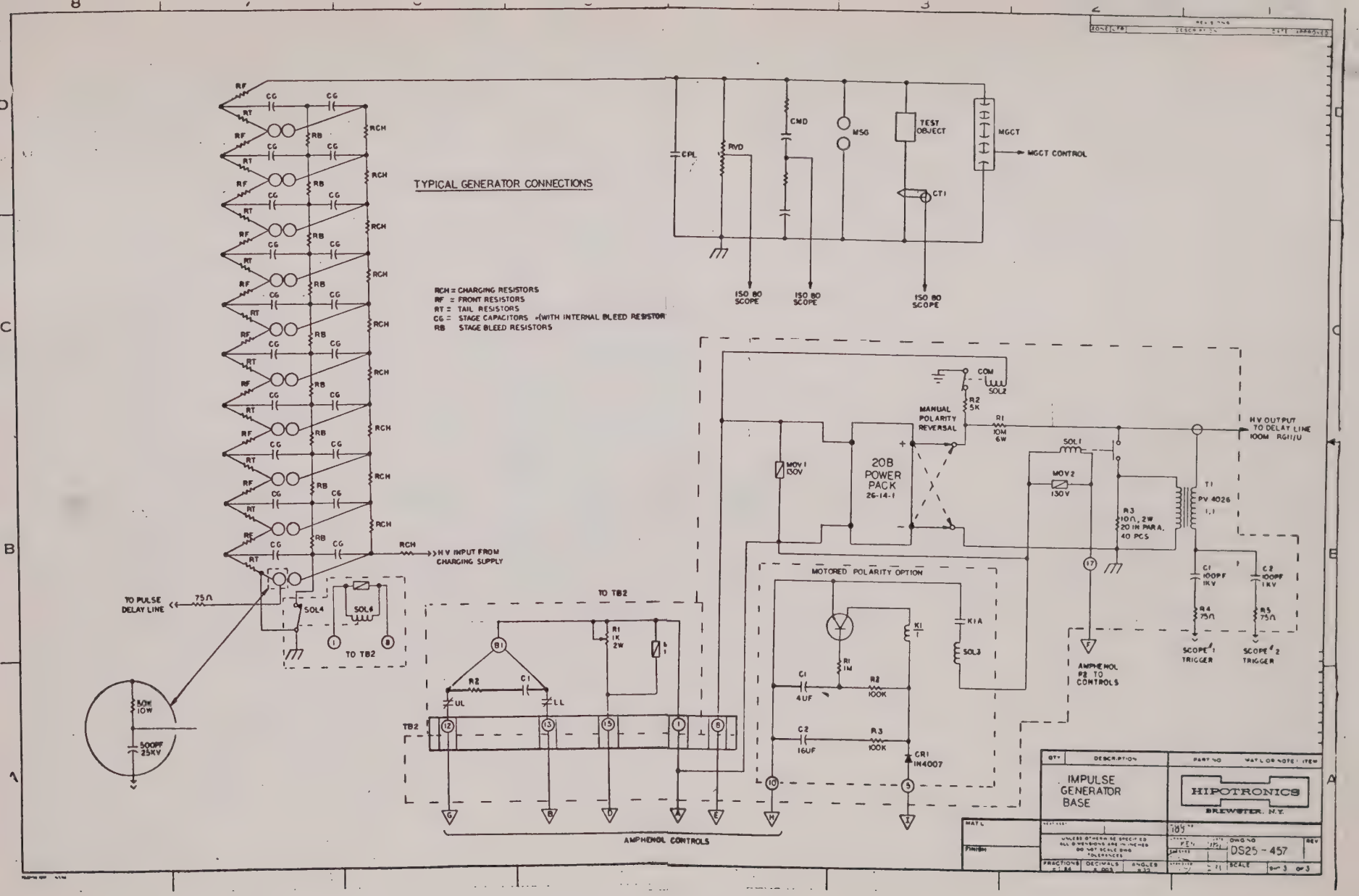
MAT'L		100	
FINISH	UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES DO NOT SCALE DWG TOLERANCES	DRAWN P.E.N. 1-21	DWG NO DS25-457 REV A
	FRACTIONS ±1/64 DECIMALS ±.005 ANGLES ±1°	SCALE	SHT 1 OF 3

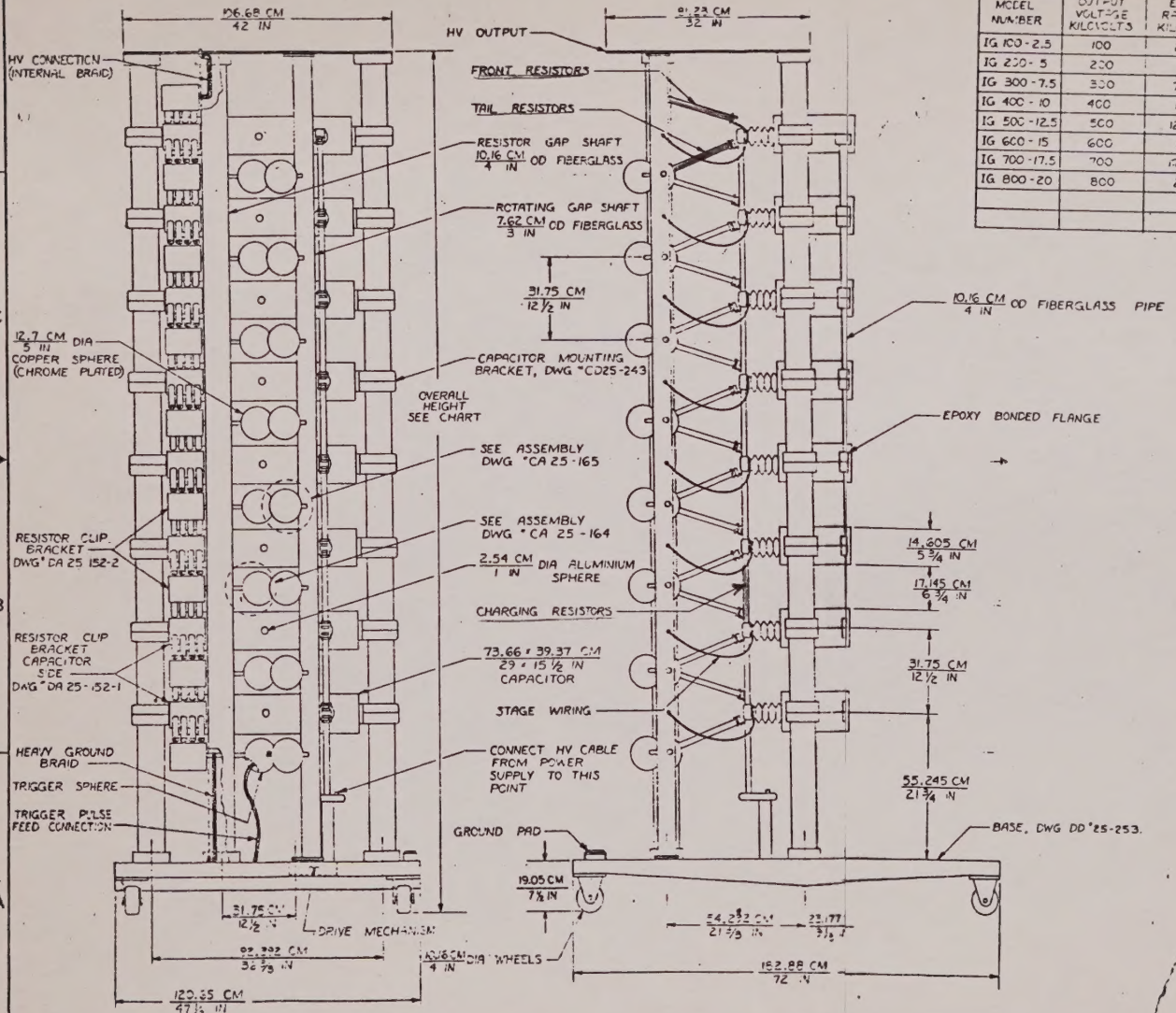


NOTES:

1. INPUT AND FUNCTION SWITCHES SHOWN WITH POWER "OFF".
2. INTERLOCKS AND OVERLOAD CONTACTS SHOWN CLOSED FOR EASE IN TROUBLE SHOOTING.
3. "A" AND "B" LINES SUPPLY CONTROL POWER AND UNLESS OTHERWISE SPECIFIED, CARRY 115 VAC
4. ▭ BOXED ITEMS INDICATE FRONT PANEL MARKINGS
5. ○ DENOTES TERMINAL BOARD CONNECTIONS
6. ● DENOTES P/C BOARD CONNECTIONS
7. ▽ DENOTES WIRE NUMBERS
8. UNLESS OTHERWISE SPECIFIED, ALL RESISTORS ARE 1/2 W ± 10 %
9. UNLESS OTHERWISE SPECIFIED, ALL CAPACITORS ARE IN "UF".
10. FOR INTERWIRING DIAGRAM SEE DRAWING NO

QTY	DESCRIPTION	PART NO · MAT'L OR NOTE ITEM
	IMPULSE GENERATOR CONTROL DESK	HIPOTRONICS BREWSTER, N.Y.
MAT'L		MODEL NO 100
FINISH	UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES DO NOT SCALE DWG TOLERANCES FRACTIONS ± 1/64 DECIMALS ± .005 ANGLES ± 30	DWG NO DS25-457 REV SCALE SHT 2 OF 3


TYPICAL GENERATOR CONNECTIONS
RCH = CHARGING RESISTORS
RF = FRONT RESISTORS
RT = TAIL RESISTORS
CG = STAGE CAPACITORS *(WITH INTERNAL BLEED RESISTOR
RB STAGE BLEED RESISTORS
CPL
RVD
CMD
MSG
TEST OBJECT
CT1
MGCT
MGCT CONTROL
150 80 SCOPE
150 80 SCOPE
150 80 SCOPE
HV INPUT FROM CHARGING SUPPLY
TO PULSE DELAY LINE
75Ω
SOL4
SOL6
TO TB2
TO TB2
R1 1K 2W
R2
C1
UL
LL
TB2
AMPHENOL CONTROLS
MOTORED POLARITY OPTION
K1A
K1
SOL3
R1 1M
C1 4UF
R2 100K
C2 16UF
R3 100K
CR1 IN4007
AMPHENOL P2 TO CONTROLS
COM
SOL2
R2 5K
MANUAL POLARITY REVERSAL
R1 10M 6W
MOV1 D0V
20B POWER PACK 26-14-1
SOL1
MOV2 130V
R3 10Ω, 2W 20 IN PARA. 40 PCS
T1 PV 4026 1:1
HV OUTPUT TO DELAY LINE 100M RG11/U
C1 100PF 1KV
C2 100PF 1KV
R4 75Ω
R5 75Ω
SCOPE #1 TRIGGER
SCOPE #2 TRIGGER
80K 10W
500PF 25KV
IMPULSE GENERATOR BASE
HIPOTRONICS
BREWSTER, N.Y.
DS25 - 457
SCALE
SHT 3 OF 3



MODEL NUMBER	OUTPUT VOLTAGE KILOVOLTS	ENERGY RATING KILOJOULES	OVERALL HEIGHT CM	OVERALL HEIGHT IN	NET CAPACITANCE (NF)	APPROX WEIGHT KG	APPROX WEIGHT LBS	NUMBER OF STAGES
IG 100-2.5	100	2.5	109.1	42 15/16	500	207	456	1
IG 200-5	200	5	140.7	55 3/8	250	295	646	2
IG 300-7.5	300	7.5	172.4	67 7/8	167	379	832	3
IG 400-10	400	10	204.2	80 3/8	125	465	1023	4
IG 500-12.5	500	12.5	236	92 7/8	100	552	1216	5
IG 600-15	600	15	267.7	105 3/8	83	637	1404	6
IG 700-17.5	700	17.5	299.4	117 7/8	71	724	1593	7
IG 800-20	800	20	331.2	130 3/8	63	810	1782	8

QTY | DESCRIPTION | PART NO | MATERIAL NOTES | ITEM

OUTLINE FOR STANDARD MULTI GENERATOR WITH SF6 100 KV CAPACITORS

HIPOTRONICS BREWSTER, N.Y.

MATL

FINISH

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES DO NOT SCALE DWG TOLERANCES

FRACTIONS DEC ANGLES

DRAWING NO 25-231A REV

SCALE 1/8" 1 OF

MP MASTER
MA35118